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**A thesis presented in partial fulfilment of the requirements for the degree of
Master of Education
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**Barriers and affordances teachers encounter when teaching mathematics for social
justice: I get it now it's racism.**

Abstract

This study examines the barriers and affordances teachers encounter when implementing a critical pedagogical approach to mathematics as well as looking at the support teachers require overcoming these barriers. In doing so, it questions if mathematics education can be re-imagined to not only meet the vision of the New Zealand Curriculum but also to create a socially just world. It builds on previous work in critical mathematics education involving culturally sustaining mathematics pedagogy and teaching mathematics for social justice.

The study applied a Freirean perspective to the teaching of mathematics. Freire asserts that in order to be transformative pedagogy must be forged with, not for the oppressed. Oppression and its causes need to become objects of reflection as from this reflection comes the necessary engagement for liberation.

The investigation took place in an inquiry-based mathematics community involving six teachers working in an innovative learning environment. Four of the teachers were Pāsifika, one was Māori and the other Pākehā. The students were predominantly Pāsifika. The teachers in the study were supported to problematize the students' world by providing mathematical tasks that examined inequity in New Zealand society. The intention was that this would challenge students to move towards a self-construction of their world based on rationality and reason that could lead to praxis or informed action. The challenges teachers faced in achieving this were then examined along with the pedagogical actions they took to move past these challenges.

A qualitative approach applying an interpretivist paradigm underpinned this study. A narrative inquiry process based on Talanoa allowed the participants voices to be heard and their story to be told. Data was gathered using an initial questionnaire and then

through ongoing open-ended interviews as well as video-recorded observations and classroom artefacts.

The findings indicate that the teachers went into the study with a narrow view of what teaching mathematics for social justice involved but through reflection and ongoing Talanoa this evolved over time to incorporate the inclusive, culturally sustaining pedagogical actions that they had previously been doing. The study also found that many of the external barriers they thought they would encounter did not eventuate and that the main (and largely unanticipated) challenge would come from the students' internalised oppression.

The studies exposure of that internalised oppression however, afforded the teachers the opportunity to confront the deficit thinking of their students and in turn confront their own beliefs about teaching mathematics. The investigation illustrated that teacher empowerment through reflection was related to the empowerment of their students and presented the possibility of liberation for both.

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Ehara taku toa i te toa takitahi, engari he toa takitini

Chapter One

Introduction

1.1 Introduction

“In mathematics, students explore relationships in quantities, space, and data and learn to express these relationships in ways that help them make sense of the world around them” (Ministry of Education, 2007a, p. 17).

Māori and Pāsifika as a group are over-represented in every single indicator of inequity in New Zealand. This includes incarceration rates, suicide, drug addiction, to homelessness and poverty. This is unsurprising considering that Māori and Pāsifika youth are over-represented when it comes to educational underachievement in core curriculum areas including mathematics. This research asks if mathematics education can be re-imagined to meet the vision of the New Zealand Curriculum and in doing so support Māori and Pāsifika students to make sense of the world around them.

This chapter provides the background context of the study which took place at an urban primary school during term four of the 2019 school year. The students were aged 11 to 13 years old and mainly came from low socio-economic home environments. They represent a range of ethnicities but are predominantly Pāsifika and Māori.

The background context outlines the international and national calls for changes to how mathematics is taught in order to make mathematics relevant to the lives of students. Knowledge of basic mathematics and statistics is an important part of gaining democratic control over the economic, political, and social structures of our society, (Frankenstein, 2010) yet mathematics traditionally has been an instrument for stratification rather than empowerment (Stein, 2004). If mathematics acts as a gatekeeper, the question is how do we ensure everybody has a key to the gate? How do

we ensure that mathematics supports students to make sense of the world around them? The question explored in this research asks if mathematics education can be re-imagined to not only meet the vision of the New Zealand Curriculum but also to create a socially just world.

1.2 Background to the Study

The Ministry of Education Statement of Intent 2014 – 2018 (Ministry of Education, 2014) states that the performance of the education system for priority students – Māori, Pāsifika, students with special education needs and students from low socio-economic areas needs to improve rapidly. Despite this, these groups remain a concern in the New Zealand Education System and a disproportionate number of these students perform below their European and Asian counterparts (New Zealand Qualifications Authority, 2013).

Traditional mathematics teaching makes little connection between applications and theory and even fewer connections to culturally relevant issues in students' lives, (Lesser & Blake, 2006). Recent reforms in mathematics education (e.g., Basu & Greenstein, 2019; Harper, 2019; Jorgensen, 2014; Shah, 2019; Stinson, 2015) emphasise the need to move away from transmission models of teaching to discursive classroom practices in which students negotiate and justify solutions to problems. However, research indicates, (Anae, Coxon, Mara, Wendt-Samu, & Finau, 2001; Averill 2018; Barton, 1995; Bills & Hunter, 2015; Hunter & Anthony, 2011, Hunter 2013),) unless these problems are drawn from the lived reality of Māori and Pāsifika students, these students will continue to feel alienated from mathematics.

The seminal work of Gutstein and Peterson (2013) drawing on Freire (2000) asserts that mathematics has the power to help us understand and potentially change the

world. To achieve this, they suggest mathematics needs to combine with other subjects. Mathematics should not be taught in a vacuum as mathematics needs social studies and social studies needs mathematics. Furthermore, they suggest that the home cultures and languages of students should be viewed as strengths and not deficits that need to be changed. When problematising the world the problems should be grounded in the lived reality of the students and draw on and value the cultural capital they bring with them to school.

Within the New Zealand context school mathematics is rarely integrated with other subjects and is often presented through a Eurocentric lens that does not value the rich background of experiences and the vast cultural history of mathematics that Māori and Pāsifika students bring to school. Hunter and Hunter's (2017) examination of research in mathematics teaching with Māori and Pāsifika students over a 15-year period found that these students often struggled to make sense of their world because of this lens. They

concluded that Pāsifika-focused culturally responsive teaching has the potential to address issues of equity and social justice which supports the retention of their cultural identity.

Hunter and Hunter (2017) suggest that for Māori and Pāsifika students to make sense of and change the world around them their world needs to be included in the mathematics classroom. As Bartolomé (1996) explains, unless educational methods are situated in students' cultural world, they will continue to show difficulty in mastering content area. This is because the learning is not only alien to their reality but may also be antagonistic to their culture and lived experiences – that is their cultural capital (Bartolomé).

Mathematics is one of the few subjects typically presented with “little or no historical, cultural, or political references,” an approach which “reinforces the institutionalization of eurocentrism, class elitism and sexism” and results in censorship of mathematical knowledge of certain cultures as “childlike and primitive” (Anderson 1997, p. 296). In order for Māori and Pāsifika students to become learners and doers of mathematics and be able to use mathematics to make sense of their world teachers need to consider the cultural context and values of students and take into account and respect their languages, culture and identity. They also need to present opportunities for students to critically examine the world they live in. Freire (2000) asserts this critical examination of the world is necessary for students to develop a critical consciousness as this leads to understanding that structures are not fixed and that they are open to transformation.

In the New Zealand Curriculum (Ministry of Education, 2007), thinking is a key competency considered vital in developing lifelong learners. The seminal work of Skovmose (1994) argues that mathematics is a curriculum area where thinking should be highly valued yet in mathematics students are often not provided with opportunities to critically examine their world, inequities and the role mathematics plays in perpetuating them. Nolan (2009) suggests that what is missing from most mathematics for social justice teaching is a critical stance on the mathematics itself. Usually mathematics is a tool for social justice projects and is presented as neutral knowledge. Yet Nolan asserts school mathematics tends to be the mathematics that grew out of European intellectual history and as such is a tool of colonialism and imperialism. Freire (1997) argues that if the naturalness of mathematics can be translated into a condition for being in the world, this will work against the current elitism within the study of mathematics. This aligns to the curriculum vision of students being able to use mathematics to make sense of the world around them.

Within the New Zealand context there appears to be little research to date that focuses on Critical Mathematics and Teaching Mathematics for Social Justice, (TMfSJ). However, internationally there is a growing field of research that builds on the work of a number of researchers (e.g., Gay, 2010; Ladson-Billings, 1995; Nasir et al, 2013, Paris, 2012) into culturally sustaining pedagogies and Ethnomathematics, which draw on the work of critical theorists.

Bills and Hunter (2015) suggest that to engage and connect Māori and Pāsifika students to mathematics not only do teachers need to consider the cultural context and values of the students they also need to consider language, culture and identity. Bills and Hunter argue that Pāsifika students enter New Zealand schools with a rich background of experiences. However, the lived reality in the school life of many of them can be significantly different from their home life experiences. This disconnect between the habitus of the school and that of the students many researchers (e.g., Anae et al., 2001; Barton, 1995; Hunter & Anthony, 2011) argue is a contributing factor in their underachievement and disengagement with their New Zealand schooling.

Hunter, Hunter, Anthony, and McChesney, (2018) argue that the underachievement of Pāsifika, Māori and other diverse cultures is not random and can be attributed to systemic factors that work to disadvantage these students. These students are taught through a curriculum and schooling system, which is positioned within Eurocentric pedagogical practices based on individualism and competition. This contrasts directly with Pāsifika and Māori notions of the value of collectivism. Along with cultural hurdles Pāsifika and Māori students often, encounter hurdles related to socio-economic factors as well (Hunter & Anthony, 2011).

This thesis will examine whether a critical mathematics pedagogy can provide for a rich rigorous mathematics education as well as address systemic inequities within mathematics education and address the needs of traditionally marginalized students. It will explore whether students can learn mathematics in a way that supports them to make sense of the world around them (Ministry of Education, 2007, p. 17) and whether students can learn mathematics in a way that supports them to read (understand) the world and write (change) the world (Gutstein, 2006).

1.3 Rationale

This research is part of a wider project working alongside teachers in over 170 schools in New Zealand as they implement culturally sustaining pedagogy into their mathematics classrooms. It builds on earlier research by Bills and Hunter (2015) that found that through culturally sustaining teaching, students were provided opportunities to not only succeed in mathematics, they were also able to engage with each other mathematically in culturally appropriate ways. The results of this study highlighted that when teachers seriously consider the cultural capital of the students, they begin to balance outcomes that are more equitable for their learners in mathematics.

When revisiting all the research undertaken around the culturally sustaining programme of Developing Mathematical Inquiry Communities, (DMIC) (e.g., Bills & Hunter, 2015; Hunter, 2013; Hunter & Anthony, 2011; Hunter & Hunter, 2017) it is apparent that students are not presented opportunities to critically examine the world they live in. By including the cultural capital of Pāsifika and Māori, students had gained academic success and cultural competence (Ladson-Billings, 1995) but they have not developed what Freire (2000) referred to as a critical consciousness. This research had created equity for the students involved by changing the way they were taught

mathematics but had not provided them with opportunity to address why the inequity existed in the first place.

Critical consciousness supports people to become masters of their own thinking. The pedagogical inclusion of cultural knowledge and lived experience, which the previous research had included, supports this. However, it is this critical consciousness Freire (2000) that allows students to see the world as a historical reality and susceptible to transformation. Freire asserts that in order to escape oppression, you must first critically recognise its causes so that through transforming actions you can create a new situation.

The earlier research also did not look at the challenges teachers face when implementing a culturally sustaining or critical mathematics programme. Freire asserts, “No oppressive order could permit the oppressed to begin to question why?” (Freire, 2000, p. 67) yet this is exactly what needs to happen if equitable outcomes are to be achieved in mathematics. If teachers are to support students to develop a critical consciousness they may need to first challenge their own beliefs about the meritocratic nature of schools. Skovemose (1994) seminal work argues that a critical mathematics education should involve reflecting through, with, and on mathematics and this assertion continues to be made by various researchers (e.g., Baron, 2015; Basu & Greenstein, 2019; Gutstein, 2006).

1.4 Research Objectives

This research looks to show the links within and between culturally responsive teaching and teaching mathematics for social justice. It highlights common themes and the importance of critical pedagogy if mathematics is to fulfil its goal of supporting students to “make sense of the world around them (Ministry of Education, 2007, p.17).

The challenges teachers encounter when introducing a critical pedagogical approach to mathematics will also be examined. The research will also examine how collaboration and reflection supported teachers to overcome these challenges.

In particular, the following research questions have been addressed:

1. What barriers and affordances do teachers encounter when implementing a critical pedagogical approach to mathematics?
2. What support do teachers require in order to overcome the barriers when implementing a critical pedagogical approach to mathematics?

1.5 Overview

Chapter 2 reviews the literature from both a New Zealand and an international perspective providing a background with which this study can be viewed. The context and framework for the current study are provided through summarising and connecting appropriate and essential literature related to critical education, critical mathematics, culturally responsive mathematics and teaching mathematics for social justice. Literature outlining the experiences teachers and students encounter when engaging in critical mathematics is also explored.

In Chapter 3, the methodology for the study is described. The research setting and sample, data collection and data analysis are discussed and a timeframe for the case study is outlined.

Chapter 4 presents the findings of the study. The perspectives of students and teachers are described and analysed. The challenges teachers faced as well as the steps taken to overcome these are illustrated.

Chapter 5, the results are discussed and conclusions are drawn. The implications for classroom practice and suggestions for further areas of research are described.

Chapter Two

Literature Review

2.1 Introduction

“There is no such thing as a neutral educational process. Education either functions as an instrument which is used to facilitate the integration of the younger generation into the logic of the present system and bring about conformity to it, or it becomes the practice of freedom – the means by which men and women deal critically and creatively with their reality and discover how to participate in the transformation of their world”, Freire, (2000, pg13).

The previous chapter presented the background context of the current study. This chapter reviews national and international literature providing the theoretical framework through which this study can be viewed.

Freire (2000) asserts that in order to be transformative, pedagogy must be forged with, not for the oppressed, by making oppression and its causes objects of reflection, as from this reflection comes the necessary engagement for liberation. Section 2.2 will unpack critical pedagogy and the work of Paulo Freire. This includes the influence of Freire’s work on critical mathematics, teaching mathematics for social justice, (TMfSJ) and culturally sustaining mathematics. The themes of domination and liberation will be used to examine the impact of the application of Freire’s critical pedagogy to mathematics education. Specifically, a key focus will be on how critical mathematics education can play a transformational role in relation to equity for marginalised students.

Section 2.3 will investigate cultural capital and the role the hidden curriculum plays in maintaining inequity within mathematics classrooms and society. It will then examine what happens when the habitus of ‘low status’ groups are viewed as strengths rather than cultural deficits. Section 2.4 will review previous research studies that

highlight the challenges that teachers face when implementing a critical mathematics programme and the ways researchers and teachers have worked to overcome these challenges

2.2 Critical Pedagogy

The seminal work of Paulo Freire (2000) has an ongoing influence on critical pedagogy. McLaren, (1994, p. 49) describes him as “the inaugural philosopher of critical education”. Freire transformed discourse around social justice by highlighting the role education plays in the formation of citizens and the perpetuation of oppressive structures within schools and the wider society (Darder, 2018).

The educational system according to Freire (2000) is an instrument of dehumanisation and the self-determination and empowerment of students from oppressed communities is thwarted by it. This dehumanisation is most evident within mathematics education through the de-culturalisation of mathematics to exclude the mathematics of students from marginalised communities (Burton, 1999; Volmink, 1994,). Mathematics education also acts as a gatekeeper where only the powerful and privileged have control over mathematical ideas (Martin, Gholson, & Leonard, 2010; Stinson, 2004; Volmink, 1994). Valencia (2010) explains that statistics are then used to blame the oppressed for their failure leading to deficit thinking that challenges the basis of a democratic education. As a result, this can lead to marginalised students holding deficit views about themselves and their communities, cultures, and a denouncing of their own cultural sensibilities and knowledge in order to emulate what Freire describes as the oppressor.

Dependency on the oppressor and belief in their invulnerability creates an inauthentic worldview that leads to disempowerment and prevents self-determination and social agency (Freire, 2000). Hunter and Hunter (2017) illustrate this in their New

Zealand study of Pasifika students conducted in several schools in South Auckland and Porirua. The students were interviewed about how they viewed themselves as both a member of a Pacific nation and a mathematics learner. A common theme in responses was to deny their cultural identity when doing mathematics, as epitomised by the following Samoan female “whenever I’m learning maths I think I’m a Pālagi (White) person...because whenever I’m doing maths I can’t remember I’m Samoan” (p. 5).

Political consciousness can be cultivated through a critical understanding of reality. If students can use mathematics to critically understand the world in which they live, they are better equipped to change that world. Although Freire’s (2000) teaching was involved with adult literacy his pedagogy is equally applicable to mathematics education. In the context of adult literacy, Freire asserts that there is a close relationship between reading the word and knowing the world. The act of reading cannot occur independently of the world in which the reader exists. After using the world around you to understand the words, it then becomes possible to use the words to understand and think critically about the world.

Freire (1997) argues that if the naturalness of mathematics can be translated into a condition for being in the world, this will work against the current elitism within the study of mathematics. Gutstein (2006) extends this argument to explain that by critically examining inequity this in turn will lead to the democratizing of mathematics and allow a way for mathematics to be used as a way to read (understand) and write (change) the world.

Mathematics is one of the most powerful, yet underutilized, venues for working towards the goals of critical pedagogy, and social, political and economic justice for all (Lesser & Blake, 2006). Teaching mathematics for social justice needs to be understood

in multiple ways; teaching about social justice issues using mathematics; teaching mathematics with a social justice lens; or teaching students to use mathematics to challenge social injustices (Gutstein, 2006).

Many researchers (e.g. Frankenstein, 2010; Gutstein, 2006; Ladson-Billings, 1995; Stinson, Bidwell, & Powell, 2012) in Critical Mathematics have applied the transformational problem posing model of education that Freire (2000) advocated as a way to challenge existing power imbalances in society leading to inequity. Within critical education, the teachers' role changes from one of solving problems for students to helping students think critically about the world around them through what Freire called conscientization, (critical consciousness). The goal is for students to come to understand why the world is the way that it is, so that they can then understand that it is not fixed and that it is open to transformation.

Through the pedagogical inclusion of cultural knowledge and lived experiences, students can become masters of their own thinking, an underlying focus of critical consciousness (Freire, 2000). To achieve this, generative issues need to be identified for which people have a passion and a willingness to act (Freire). Freire identifies domination and liberation as the overarching or global generative themes. Gutstein (2006) building on Freire's thinking viewed the idea of liberation from oppression as the fundamental purpose of teaching for social justice. He proposed that Teaching Mathematics for Social Justice (TMfSJ) should flow from this notion of liberatory education. He identified two sets of pedagogical goals for TMfSJ: one focused on social justice and one on mathematics. His framework for TMfSJ aligns with Ladson-Billings (1995) criteria for culturally responsive teaching.

2.21 Teaching Mathematics for Social Justice

Gutstein's (2006) social justice pedagogical goals include a) students able to 'read' or understand the world with mathematics b) students able to 'write', or change the world with mathematics and c) students develop positive cultural and social identities. His three mathematical pedagogical goals are a) students able to read the mathematical word b) succeed academically in the traditional sense and c) that students change their orientation to mathematics.

Mathematical literacy within Gutstein's (2006) framework is broken into functional and critical literacy. Functional mathematical literacy involves all the competencies needed to function within a given society but is not enough as it merely serves the reproductive purposes of dominant interests. In contrast, critical mathematical literacy supports students to see relationships, look for underlying explanations, and question whose interests are served and who benefits. Critical mathematical literacy helps students' recognise oppressive structure so they can participate in creating a more just world or in the case of the New Zealand Mathematics Curriculum "explore relationships in quantities, space, and data and learn to express these relationships in ways that help them make sense of the world around them" (Ministry of Education, 2007, pp. 17).

A common criterion for engaging in critical mathematics education is the notion of teaching mathematics about, with, and for social justice (Stinson & Wager, 2012). They explain that teaching mathematics about social justice refers to the context of lessons that explore critical social issues using mathematics. Teaching with social justice refers to the pedagogical practices that encourages a co-created classroom and provides a classroom culture that encourages opportunities for equal participation and status. In addition, teaching mathematics for social justice is the underlying belief that mathematics

can and should be taught in a way that supports students in using mathematics to challenge the injustices of the status quo.

Having students become critically, conscious of their own reasoning can happen in mathematics classrooms. In a research study by Stinson, Bidwell, and Powell (2012), the researchers and two secondary teachers collaboratively examined how the teachers learnt to teach in socially just ways. A process of ongoing narrative and reflection by the teachers was used as the teachers and students engaged in a critical consciousness activity. A generative theme of domination was drawn on when introducing a TMfSJ approach to teaching mathematics. Racial profiling and minimum wage data were selected as starting points when planning their TMfSJ lessons. Each lesson involved both a personal and political element for the students and teachers. The critical approach taken by Stinson and his colleagues provided opportunities to raise critical awareness. It also included student and teacher voice and their lived experience in the learning process leading to a critical democracy. Through this means, mathematics was used to make sense of the socio-political world of the participants. New knowledge was created rather than the reproduction of the dominant group knowledge that a traditional approach would have generated. This meant that mathematics was able to help the students move through the theme of domination towards the possibility for liberation.

The generative themes of domination and liberation have also been used in other studies. Planas and Civil (2009) worked with teachers taking an empowerment perspective. Within this frame, the issues of power and powerlessness, integral to the school experiences of immigrant students and teachers are addressed. Planas and Civil through drawing on the work of Gutiérrez (1995) explain that empowerment is a process of increasing personal and inter-personal power so that individuals can act and improve their situation. They argue that individuals who feel they have power are more likely to

contribute to actions that lead to social change. In this study, the use of student realities as a mathematical resource led to the realisation of empowerment opportunities and the development of new relationships within the classroom. The empowerment of participants did not eliminate all old practices but lead to greater teacher reflection and the development of reciprocity in the teacher/student dynamic. Teachers examined their own deficit beliefs about immigrant students and recognised how their lowering of mathematical challenge influenced participation and opportunities to learn. Teacher empowerment through reflection directly related to empowerment of the students and presented the possibility of liberation for both groups.

In order to engage in TMfSJ, effective teachers need both subject mathematical knowledge and political clarity to create, adopt, and modify teaching strategies that simultaneously respect and challenge learners from diverse cultural groups in a variety of learning environments. Gutstein (2003) illustrated how this could be done in a two-year study in an urban, Latino classroom. A series of seventeen real world projects were developed to provide opportunities for students to ‘read and write their world’ with mathematics. The projects connected to the students’ lives but also examined themes of race, racism, discrimination, and power. They included topics such as racism and house prices, the worldwide distribution of wealth, and why students of colour, females and low-income students scored lower on exams. The goal was to have students raise questions as opposed to answering them and thus develop social and political consciousness, a sense of agency, social and cultural identities, and meet mathematics-specific objectives.

Gutstein (2003) describes how over time students began to understand complex issues involving justice and equity using mathematics, develop mathematical power, and change their orientation toward mathematics while also mastering content. Gutstein

explains that having relevant, meaningful contexts was only part of the required conditions and that a classroom culture that supported analysis of such contexts was also needed. Teachers and students needed to create classrooms where they openly and honestly discussed justice and developed reciprocity to address power imbalances in the student teacher dynamic. He believed that this co-created classroom environment contributed most to the growth of his students.

Teaching Mathematics for Social Justice requires more than exploring critical social issues or challenging injustices through mathematics. The pedagogical practices and a classroom culture that encourages opportunities for equal participation are also important. (Gutstein, 2003; Planas & Civil, 2009; Stinson & Wager, 2012).

The focus of TMfSJ has largely been on examining inequity through statistics rather than examining the nature of mathematics itself as a gatekeeper, or the dynamics of student teacher relationships. Various researchers (e.g., Gutiérrez, 1995; Gutstein, 2003; Planas & Civil, 2009; Stinson & Wager, 2012) suggest that TMfSJ needs to not only address inequities in society but also address the inequity that exists in mathematics, mathematics classrooms, and within schools. While mathematics is an invaluable tool for social critique, it must also be the subject of critique (Skovsmose, 1994). What counts as mathematics, what counts as knowledge, whose knowledge is included and whose knowledge is excluded and more importantly, whose purpose is served and most importantly why? Consequently, when thinking about TMfSJ the question needs to include not only what we teach but also how it is taught. To do this, we must first understand cultural capital and the role the hidden curriculum plays in maintaining inequities within mathematics classrooms.

2.3 Cultural Capital

Bourdieu (1973) developed the concept of cultural capital., McLaren (1994) further defined this as being the general cultural background, knowledge, disposition, and skills passed on from one generation to another. Cultural capital represents “ways of talking, acting, and socialising, as well as language practices, values, and types of dress and behaviour” (p. 219). This becomes a form of ‘capital’ within institutions such as the justice system and the education system.

Bourdieu (1973) viewed schools as imposing class-biased valuations that became the social currency of manners, practices and knowhow (Davies & Rizk, 2017). This vertical stratification compounded further when presented as meritocracy. Schools would appear to be neutral institutions that reward effort and ability on a level playing field where everyone has an ‘equal opportunity’. Bourdieu (1973) suggests that these valuations are arbitrary, and class biased.

Jones (1991) highlighted a lack of neutrality in a New Zealand study set within an urban girls’ high school attended by both Pāsifika and Pakeha girls. Schooling was central to the maintenance of existing social relations of dominance and subordination through both ideological and pedagogical processes. Teacher actions precluded working class Pāsifika girls from achieving the academic credentials they sought; in contrast, middle class Pakeha girls were privileged to achieve academic success. The differentiated outcomes were accepted as fair, due to the meritocratic nature of schools and the participants’ beliefs about differential effort and ability. In this study, Jones illustrated some of the ideological and pedagogical processes through which schooling contributes to social reproduction.

2.31 The hidden curriculum

The hidden curriculum is another aspect needing consideration when thinking about the role of schooling. Bowles (1972) and Anyon, 1980, 1995 (as cited in Wager & Stinson, 2012) build on Bourdieu's assertion that class bias exists within schools and that schooling experiences differ qualitatively by class. Anyon) argued, "Via the hidden curriculum, children are positioned for specific tasks that suit stratified society and emphasise different cognitive and behavioural skills" (p. 7). Anyon claims that different schooling experiences not only support class division but also produce and reproduce unjust division through differing curricula and pedagogical and evaluation practices. Her thinking extends beyond social class to explain the inequities faced by various marginalised groups.

Kidman, Yen and Abrams (2012) studied indigenous students' experiences of the hidden curriculum in science education in New Zealand and Taiwan. Their findings suggest that the peripheral positioning of indigenous culture and knowledge within the science curriculum contributed to indigenous students' disengagement with the subject and to the reproduction of unequal outcomes. They contend that disengagement with science among indigenous learners is the result of exclusionary pedagogical and epistemic practices that sit beneath the official science curriculum marginalising indigenous learners. A key disconnect was between indigenous knowledge systems about the natural world and what was viewed as high status scientific knowledge. This effectively marginalized and excluded indigenous learners and the cultural dispositions and orientations they carry with them into the classroom.

2.32 The role of mathematics as a gatekeeper

Mathematics is a gatekeeper with school mathematics used to stratify students, afford privilege to some, and limit opportunities for others (Stinson, 2004). Drawing on Bourdieu's work, Gates and Jorgensen, (2009) argue that as the habitus of dominant groups aligns more closely with school mathematics; this provides advantages to these groups whilst simultaneously disadvantaging already marginalised groups. In an ethnographic study, Acar (2012) explored the extent social reproduction was created as academic knowledge via the hidden curriculum in a mathematics class. The study also examined the role the teacher played in transmitting social reproduction to the academic learning situations in a classroom.

The Acar (2012) study involved twenty students aged nine to 10 years old. The students came from working class families and had similar cultural and socio-economic backgrounds except one student who had a Spanish cultural background and spoke Spanish as their first language. The study found that the teachers' expectations and activities provided in the classroom did not just reflect the mathematics curriculum they also reflected the social, cultural, and political patterns belonging to society. Furthermore, examples in textbooks, the hidden patterns in seating plans, tables, brochures and other patterns in the physical environment used for managing the classroom were aligned to those that maintained social order in society. A key finding of the study was that all students were affected by the hidden curriculum, but some students actively tried to control the classroom environment. These students rejected the norms of obedience and respect for authority. Their resistance necessitated the need for the creation of an environment for continually repeating the patterns of social production; that is assimilation.

Yeh and Otis (2019) also explored the hidden curriculum in mathematics classrooms as a means through which structures of power and privilege are maintained. They argue that schools teach more than just subjects, and that every decision a mathematics teacher makes sends powerful messages to students about what is valued and whose knowledge and experiences are deemed important. Schools, they argue, are not only a site for social reproduction; they also have the potential to be sites for transformation. When students' ideas and identities are honoured and leveraged, education can, among other things, help bring equality and justice to an unjust world, (Yeh & Otis).

Yeh and Otis (2019) examined how teachers could develop curriculum that drew on students' knowledge and experiences and supported development of both socio-political consciousness and mathematical competencies. Yeh and Otis worked in collaboration with teachers and students to analyse mathematics textbook word problems and to consider ways to use mathematics to analyse social inequities in the world. This analysis demonstrated that commonly, word problems failed to depict realistic and relatable applications of mathematics to the lived reality of students. Instead, the problems created superficial scenarios as a context for teaching what appeared to be more highly valued mathematics. These also reinforced stereotypes around gender, sexuality, race, culture, and social class and did not acknowledge the variety of languages spoken within school communities. As the study progressed, teachers and students were able to see that all word problems are carriers of cultural values and that they privileged certain worldviews.

This study highlights that with support, teachers can “unlearn” the mathematics they experienced as students to relearn the possibilities to teach mathematics for social justice for their students. This encapsulates what Freire (1992) termed a pedagogy of

hope, in which schools can be sites of transformation impacting on and challenging the hidden curriculum.

2.4 The dilemma between TMfSJ and Teaching Mathematics

Teaching mathematics for social justice and culturally sustaining mathematics teaching has the potential to address systemic inequities within mathematics education as well addressing the needs of traditionally marginalized students (Bills & Hunter, 2015; D'Ambrosio, 1985; Gutstein, 2006; Wright, 2016; Yeh & Otis, 2019). However, there is concern that a focus on social and political issues may take priority over the learning of rich, rigorous mathematics (Wager & Stinson, 2012). Likewise, Bartell and Carpenter (2008) question how teachers can develop an understanding of social justice issues; have the pedagogical skills to engage students in what can be controversial issues while at the same time attend to the teaching of mathematics.

Bartell (2015) asserts that the notion that mathematics is culture free has been normalised and is now seen as a universal truth and that these beliefs can lead to teachers disregarding students' cultural and linguistic backgrounds. When mathematics has traditionally been seen as culture free, dissonance can be created for teachers when they are told that in order to effectively teach diverse learners, they first need to understand the culture and lived experiences of their students and incorporate these into the classroom (Bartell).

Esposito and Swain (2009) explored the challenges teachers face when implementing critical mathematics pedagogy. Their study examined urban teachers' use of culturally relevant pedagogy as a conduit to TMfSJ. The study was conducted with seven African American teachers who all taught in urban schools with children ranging in age from six to 15 years of age. They found that the implementation of culturally

relevant and social justice pedagogies could support students to effect change in their communities and broader society. Key findings included that teaching for social justice involved risk, time, and self-reflection. As Ernest (1991, p. 212) explains, the public educator “is at risk of being seen as attempting to subvert mathematics education into a propagandist activity” and must anticipate the opposition of conservative critiques.

Another theme emerging from Esposito and Swain’s (2009) study, related to the dissonance caused by teachers challenging their students to think critically about the inequities within their schools and broader society. In doing so, students were encouraged to question authority, a practice seen as a threat by school officials. Esposito and Swain explained that faced with the economic reality of needing jobs, many urban educators were not prepared to take the risk, with only one participant communicating that she was willing to risk everything to best meet the needs of her students.

Teachers’ reluctance to take risks was also part of Takker’s (2017) findings with teachers in urban schools in India teaching students twelve to fourteen years of age. The teachers in this study used textbooks that contained mathematics word problems with a social justice theme. The teachers either deleted the reference to social justice issues or only briefly mentioned them whilst keeping the focus on the mathematics, specifically teaching the algorithm required for solving the problem in the quickest most efficient way. Both teachers selectively omitted discussing the conflict arising from the mismatch in the salary decided by the government and given to the workers, as well as the differential treatment to women and men.

Takker (2017) explained that the first teacher stated that they should avoid such things in class as it created conflict. The second teacher saw the inequity as related to outside knowledge and was unsure of how to handle this in the classroom. Both teachers

believed that they had covered the mathematics component of the lesson which fitted within their own experiences of learning mathematics and viewed the social justice component as a ‘deviation’ from learning what is understood as ‘important school mathematics’.

Takker (2017) and Esposito and Swain’s (2009) research studies occurred in two different countries and resulted in vastly different levels of dissonance in terms of willingness to engage in risk. Despite this, both studies highlight that teachers need support in acquiring the knowledge to discuss and handle social conflicts in a classroom whilst balancing the need to teach mathematics in such situations. In both studies, teachers were in lower positions of power or privilege in terms of job security or socio-economic status, which accentuated their level of risk when introducing controversial topics that challenged existing power imbalances.

In contrast, Bartell’s (2006) study with eight white, middle class teachers who inhabited a more privileged space did not find any concerns from the teachers about the risks involved with TMfSJ. This study however, like the Takker (2017) and the Esposito and Swain (2009) did identify challenges related to time, as well as how to balance and integrate social justice, and mathematical pedagogical goals.

The Bartell (2006) study followed eight secondary mathematics teachers as they collaboratively designed, implemented, observed, revised and re-taught a mathematics lesson for social justice. The study traced the conversations teachers had around what it means to teach mathematics for social justice and the challenges that they recognized that they faced in implementing these ideas into practice. The teachers’ reflections in Bartell’s research suggested that they considered that students must first learn or know the mathematics and then use that mathematics to learn about and analyse social issues. The

idea that students should learn mathematics first and then apply it to understand social issues implied that teachers' saw the TMfSJ as something added on to a curriculum, rather than something that might be an integral part of the curriculum. The design of the study as a one-off lesson may have facilitated this notion of TMfSJ as an add-on.

Wright's (2016) study of social justice in mathematics classrooms examined how teachers could enhance students' engagement and agency by making mathematics more relevant and meaningful through planning, teaching, and evaluating innovative classroom activities. The study involved five teachers in their second year of teaching in schools in low socio-economic areas of London. The students were aged between thirteen and sixteen and many spoke English as an additional language. The teachers in the study engaged professional readings on TMfSJ as well as collaborative lesson planning and reflection. The mutually supportive nature of the study supported teachers to take risks in developing alternative classroom practices.

Teachers were encouraged to engage in research and discuss how the research related to their own teaching experiences. Pedagogical imagination developed as teachers critically examined their own practice. The study found that teachers over time became critical of conventional mathematics teaching seeing its procedural nature as alienating some students. At the same time, their belief in student centred collaborative, problem solving approaches to learning increased. Despite these shifts in beliefs, the teachers still saw the importance of teaching discrete mathematical skills as the focus that could be complemented by analysing issues of social justice. Some students were also concerned that they were not learning real or proper mathematics.

The teachers in the Wright (2016) study found that the opportunity to work collaboratively with other teachers from different schools was positive. The supportive

nature of the collaboration encouraged them to take risks and overcome many of the challenges and constraints they encountered in developing alternative classroom practices. The collaborative nature of the group discussions also supported teachers to develop a greater understanding of the links between social justice and mathematical skills. This helped resolve the conflict of raising social justice at the same time as ‘getting through’ the mathematics course work required. Being able to share ideas and resources also compensated for the extra time required to plan activities.

The need for teacher collaboration within and across schools appeared to be a common theme that emerged across the literature as a way to support teachers to meet the pedagogical and content specific demands that TMFSJ places on teachers. Bartell (2006) suggests that through collaboration teacher groups could examine social justice issues, and then engage in the identification of appropriate data, asking questions such as, “What mathematics would I need to understand and examine this issue?” “What data do I need to support this conclusion, and why?” as a way of integrating the mathematics with the social justice.

Takker (2017) also asserts that the development of communities of teachers and researchers working together to identify and discuss the issues arising in TMfSJ is required to analyse the demands posed on teachers when integrating social justice issues in classrooms. These demands include the considerable amount of time planning lessons and making resources to support TMfSJ as well as spending their own money to supplement the resources provided by the school system that the Esposito & Swain’s (2009) study highlighted.

Reflection is an important component in overcoming the challenges and constraints of TMfSJ. If teachers do not reflect on their personal philosophies, they will

continue to re-create the “reified typifications of mathematics” (Lesser & Blake, 2006, p. 167) in the classroom. Skovemose (2011) argues that a critical mathematics education should involve reflecting through, with, and on mathematics. Wright (2016) illustrated that through reflection the teachers gained a greater awareness of the structural causes of inequity in mathematics education. There was also a growing awareness that a narrow focus on raising the attainment of disadvantaged students while ignoring the structural causes of inequity resulted in low risk teaching and procedural understanding.

A developing awareness through reflection was the focus of a study by Baron (2015). In this study set within urban American secondary schools with seven teachers of students aged between thirteen and eighteen, Baron investigated how teacher’s beliefs about teaching mathematics can be transformed through reflection. She argued that unexplored teachers’ beliefs can be a barrier to pedagogical growth and therefore teachers’ beliefs need to be examined. Through the reflective practices designed for the study, she anticipated that teachers would become able to make sense of their beliefs and practices. This would lead to enlightenment (becoming aware) which could provide possibilities for empowerment (becoming critical) through to emancipation (taking action) Baron.

The results of Baron’s (2015) study indicated that through reflection, teachers developed an awareness that they needed to understand, explore and articulate their own beliefs and practices and through this process, they were able to challenge the validity of them. They also developed an understanding of what led to the construction of these beliefs and the barriers they faced to overcome them including going outside of their comfort zones. This led them to being able to take action by implementing a lesson that they considered a risk-taking experience and by developing the confidence to describe their shifts in beliefs and practices in public forums.

Through reflection, Bartell (2006) illustrated that the teachers' narrow view of TMfSJ expanded over time as they collaborated and discussed what was occurring in their classrooms. The conversations moved from viewing teaching mathematics for social justice as about relating mathematics to all cultures or relating mathematics to society, towards providing students opportunities to look critically at how societal issues connect to their experiences or providing opportunities for students to act upon their world in order to transform it. Planas and Civil (2009) showed that teacher empowerment through reflection was related to the empowerment of their students and presented the possibility of liberation for both. Stinson, Bidwell and Powell (2012) also showed that an ongoing process of narrative and reflection was required for students and teachers to develop their critical consciousness.

2.5 Summary

Teaching mathematics for social justice (TMfSJ) stems from the belief that all children should have access to rich, rigorous mathematics that provide opportunities and self-empowerment for them to understand and use maths in their world (Wager & Stinson, 2012). Teaching mathematics for social justice involves a variety of factors. These include teachers teaching about social justice issues using mathematics, teaching mathematics with a social justice lens, or teaching students to use mathematics to challenge social injustices (Gutstein, 2006; Stinson & Wager, 2012). TMfSJ needs to not only address inequity in society but also address the inequity that exists in mathematics itself, in mathematics classrooms, and within our schools (Gutstein, 2003; Planas & Civil, 2009; Skovmose, 1994; Stinson & Wager, 2012).

Teaching Mathematics for Social Justice requires more than exploring critical social issues or challenging injustices through mathematics and within mathematics. The

use of relevant cultural contexts and having students pose questions related to complex issues involving equity on their own does not lead to the empowerment of students. The classroom culture that supports the analysis of such contexts was just as important as the contexts themselves. Various studies within this literature review have highlighted the importance of pedagogical practices and a classroom culture that encourages opportunities for equal participation if education is to become the ‘practice of freedom’ in which people discover how to participate in the transformation of their world (Freire, 2000). Teachers and students needed to co-create classrooms and draw on reciprocity to address power imbalances in student and teacher dynamics. Both reflection and collaboration were integral to achieving this.

The teaching of mathematics for social justice presents many challenges for teachers. This includes concerns that a focus on social and political issues will take priority over the learning of rich, rigorous mathematics. Furthermore, some teachers consider TMfSJ a risk due to the possibility that having students think critically and challenge existing power structures could be seen as challenging authority within the school system. Other challenges faced by teachers involved time including the time required for planning lessons and including social justice within the time they had to deliver the lesson and cover the mathematics curriculum.

Despite these challenges, research indicates that TMfSJ can lead to improved academic success for diverse learners whilst addressing cultural competence and developing critical consciousness when teachers are provided with adequate support.

Chapter Three

Research Design

3.1 Introduction

The preceding chapter gave an overview of research on Critical Mathematics and the challenges teachers face when introducing a critical pedagogy into their classrooms. This chapter outlines the design and methods used in the study. Section 3.2 provides justification for the selection of a qualitative approach for this project and describes the use of case study design. Section 3.2.1 looks at the validity and reliability of the research method selected. Section 3.3 outlines the role of the researcher. Section 3.4 describes the setting, the participants and the research schedule. Section 3.5 discusses the data collection methods used in this investigation. Section 3.6 details the data analysis. Section 3.7 highlights the ethical considerations for this study and Section 3.8 provides a summary of the chapter.

3.2 Justification of Methodology

The aim of the study was to identify the challenges teachers face when introducing a critical mathematics pedagogy and to explore ways in which they overcome these challenges. A secondary aim was to determine what impact (if any) a critical mathematics pedagogy has on the engagement and mathematical dispositions of students.

A qualitative research approach was selected for this current study as it allowed the studying of people in their natural settings. “Qualitative research is multimethod in focus, involving an interpretive, naturalistic approach to its subject matter. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them”, (Denzin and Lincoln, 1994, p. 2). Polkinghorn (2005) states that qualitative research is an umbrella

term that encompasses a variety of research methods that use language data. As the research was concerned with understanding the teachers and students' narrative, a qualitative approach was necessary. Smith (2005) argues that qualitative research is an important tool as it provides space for hearing the voices of the silenced and allows for dialogue across difference in order to make sense of complex and shifting experiences. Qualitative researchers use a variety of tools and techniques in order to develop deep understandings of how people perceive their social realities and how they act within the social world.

A case study approach is utilised in the current study. Miles and Huberman, 1994 (as cited in Punch, 1998) define a case as a phenomenon occurring within a bounded context. Case study allows research in a bounded system (Creswell, 2009) or case, utilizing informative and contextual data to interpret findings about the phenomenon being explored. In the current study, the classrooms, teachers, and students form the bounded system of the phenomenon being studied. Zainal (2007), states that case study can be considered a robust research method especially when a holistic, in-depth investigation is required. He asserts that through case study methods the researcher is able to go beyond quantitative statistical results and understand the behavioural conditions through the perspective of the participants. Drawing on Yin's (1984) categories of case study an exploratory case study was necessary as there appeared to be little preliminary research available and data collection was required to find out commonalities across classrooms and to form a hypothesis.

The current study takes a critical approach to qualitative research whilst employing an interpretivist paradigm. An interpretivist paradigm is often associated with qualitative methods and is concerned with understanding the world as it is from the subjective experiences of individuals. Griffiths (2009) states that critical research is not

a tidy category as it aims to “understand, uncover, illuminate and/or transform how educational aims, dilemmas, tensions and hopes are related to social divisions and power differentials” (p. 1). Critical educational research has emancipatory intent, and therefore has the potential to be empowering although there is no guarantee that this empowerment will occur (Smith, 1993).

Smith (1993) asserts that research approaches, which politically empower people, are those concerned with professional growth and participation in education decision-making. Making teachers more knowledgeable enhances their power. In order to achieve this, reciprocity and reflexivity need to be incorporated into the research process, not just as a method to verify data, but to support change. The research design therefore needed to engage the participants in critical dialogue, decision-making and strategic action.

As this case study was concerned with the potential empowerment of teachers and students and challenging structural inequities, authentic participation of the researched in the research was required. Smith (1993) suggests achieving this requires the traditional distinction between the researcher and the researched be replaced by the sharing of perceptions and self-reflections of all participants who have an interest in the outcomes of the research. Talanoa was selected as the method to achieve this as it removes the distance between researcher and participant and provides research participants with a human face they can relate to (Vaiotei, 2006). Talanoa is carried out in an environment of trust, respect, cooperation and a willingness to reach a status of understanding and relationship (Halapua, 2003).

Talanoa is similar in approach to narrative research. However, in the Talanoa approach participants can provide a challenge or legitimization of each other's stories (Vaiotei, 2006). Vaiotei asserts that because the Talanoa approach is flexible, it can

provide opportunities to probe, challenge, clarify and re-align the narrative. As the shared outcome of Talanoa is contextual, it provides robust up to date knowledge devoid of “academic sanitisation” (p. 26). This provides a richness and depth of information that may not have been as readily accessible by using another method.

3.21 Validity and Reliability

Case study is often criticised for its lack of rigor in the collection, construction, and analysis of the empirical materials that give rise to the study. It can be argued that the researchers own subjective feelings may influence the case study. Many researchers (Guba & Lincoln, 1981, Hamel, Dufour, & Fortin, 1993; Yin, 1984) note the potential for researcher bias. Flyvbjerg (2006) however, suggests that there is no greater bias in case study toward confirming preconceived notions than in other forms of research especially if the data is triangulated. Triangulation, referred to earlier in this chapter, is a way to enhance internal validity and reliability. Triangulation is a way of assuring the validity of research through using a variety of methods to collect data on the same topic, which involves different types of samples as well as methods of data collection. As well as being a method to cross validate data it also allows for the capture of different dimensions of the same phenomenon.

In the case of Talanoa, Vaiolati (2006) argues that the embedded reciprocity raises the expectations that researchers and participants have of each other, promoting mutual accountability. This adds to the trustworthiness and quality of the research as the researcher will not want to let down participants with whom he or she has developed a relationship. Linda Smith (2005) asserts that the ability to build, maintain and nurture relationships, to strengthen connectivity are important in the indigenous arena and that this requires sensitivity and reciprocity of spirit by the researcher. (Bishop & Glynn,

1992, as cited in Smith, 2005) make the point that this is not about making friends but about the awareness to engage in power sharing.

Applying conventional interpretations of research validity and reliability to Talanoa can create problems as Talanoa affects the learning of both researchers and participants (Vaiotei, 2006). As reliability is concerned with consistency Talanoa research methodology is unlikely to yield similar results over time as participants' viewpoints and reactions will change. Vaiotei asserts that this can be seen as a strength not a weakness of Talanoa as the participants involved will be the most suitable and knowledgeable for that particular time. Drawing on the work of Lincoln and Guba 1985 (as cited Cohen & Morrison, 2001) Vaiotei suggests that "replacing validity and reliability with trustworthiness and its components is more fitting" (Vaiotei, p. 32). The social constructivist approach of Talanoa acknowledges the interdependence of those involved in the research and ideas about absolute truth are replaced by critical reflections on the knowledge constructed.

3.3 Researcher Role

Case study researchers' main purpose is to develop a deep understanding of a case in its natural environment by collecting data and analysing it. The role of a case study researcher includes designing and preparing the study; conducting the investigation and data collection; as well as interpreting and reporting the results of the study. As the researchers' main purpose is to develop a deep understanding of a case in its natural environment by collecting data and analysing it, they usually but not always, act as outsiders by observing and questioning and they often have limited control over the action and interactions within their case studies.

Simon (2011) asserts that qualitative researchers need to define whether their role is emic, an insider who fully participates in the phenomenon or more etic, from an outside or more objective view. Punch (1998) argues that there are variations to this and that emic to etic is more of a continuum. A researcher may begin as an outsider and then become a member of a group or start out as an insider before becoming a more objective observer. Looking at qualitative research from a traditional Western perspective the role of the researcher in the current research was that of participant observer. This requires the researcher to become integrated into the participants' environment while also taking objective notes about what is going on.

Narayan (1993) argues that defining researchers in terms of insider/outsider status is no longer useful and that instead of thinking in terms of an insider/outsider dichotomy, researchers should be viewed in terms of “shifting identifications amid a field of interpenetrating communities and power relations” (p. 671). The factors that align and that separate researchers from those being researched are multiple and constantly changing so at various times this will affect the insider/outsider identity of the researcher (Narayan). Rather than focus on the role of the researcher as etic/emic, Narayan argues that we should instead focus on the quality of the relationships the researcher has with the people they seek to represent. Does the research allow for the subjects voices, views, and dilemmas to be heard, as well as allow for a reciprocity of understanding, critique and benefit for all those involved (Narayan).

Through the role of mathematics mentor¹, the researcher had spent considerable time in the school and the classrooms where the research took place. Prior to the research beginning, they had developed professional and collaborative relationships with the

¹ The researcher is a teacher educator who works in schools as a mathematics mentor supporting teachers in their classrooms as they enact culturally sustaining mathematics.

teachers involved in the current study. The researcher was also known to the students involved in the research and was an accepted part of the setting. The researcher did not take an active part in the lessons as student or teacher whilst they were happening. However, the researcher was involved in the professional development meetings and planning of the lessons including anticipating student responses, as these were co-constructed by the whole group.

The researcher grew up and attended school in the community in which the research took place. He retains deep whanau ties to the community in which the school is located and considers the area his Tūrangawaewae². Even though the researcher did not take an active part in the lessons whilst they were happening, it can be argued that the researcher entered the study with certain assumptions and biases, which needed to be carefully monitored over the duration of the project. These include beliefs about the ability of the teachers involved in the study as well as a respect for the transformational work that the school (teachers, leadership, students and whanau/fanau/family) has been involved in over the years. Having grown up in the community the researcher also has first-hand experience of the consequences that a disconnect between school and the community can have on the lives of students. Creswell (2002) claims that within qualitative research “all interpretations are subjective assessments by the researchers, and that individuals can never be “neutral” or remove themselves from the study to report objectively” (p. 278).

Bishop (2005) argues that this preoccupation with neutrality, objectivity and distance has worked against Māori people participating in the construction, validation,

² Tūrangawaewae² (a place to stand). Tūrangawaewae are places where people feel especially empowered and connected.

and legitimization of knowledge. He asserts that in Kaupapa Māori Research personal investment is essential but that it is not on the terms of the investor but through mutual or reciprocal understandings. Read, Greaves and Kirby, (2016) suggest that ‘all’ research reflects a point of view whether it is declared or not.

Thorne, (2008) asserts the key is integrity of purpose not only with yourself but also between yourself, your project and your eventual audience and that it is only through honest and critical reflection that you can ensure the research you are involved with is true to purpose and meaningful. Talanoa is subjective, mostly oral and collaborative and it requires researchers to partake deeply in the research experience rather than stand back and analyse (Vaioliti, 2006). The researcher therefore takes on a social constructivist role as the research is socially situated and the knowledge and understanding has been constructed through interaction with others. This kind of knowledge has relevance for participants as well as researchers and can be transforming.

3.4 The Research Study: Sample, Setting and Schedule

This section describes the setting for this investigation, the details of the participants and the phases of the study.

3.41 The Setting and the Sample

This project took place at an urban primary school during term four of the 2019 school year. This school has a Decile rating of 1³. The students at this school mainly come

³ Each state and integrated school in New Zealand is ranked into deciles, low to high, on the basis of an indicator. The decile indicator measures the extent to which schools draw from low or high socio-economic communities. Decile 1 is the lowest and decile 10 is the highest.

from low socio-economic home environments and represent a range of ethnicities but are predominantly Māori and Pāsifika.

The investigation took place with the year 7 and 8 syndicate of the school with students ranging in age from eleven to thirteen years old. The six teachers involved in the study share a collaborative learning space referred to as an Innovative Learning Environment or ILE. The teachers come from a variety of ethnic and socio-economic backgrounds and have varying levels of experience in teaching. Pseudonyms have been allocated for the teachers and students involved. Mathematics teaching involves using the inquiry model Developing Mathematical Inquiry Communities (DMIC) which is the research on which Best Evidence Synthesis 1, Ngā Kete Raukura – He Taura 1 is based on. The majority of the students involved in the teaching episodes had been in DMIC classrooms for at least six years so were experienced in discourse-based inquiry mathematics.

Initially two teachers were selected by the researcher to be involved in the study but after discussions with the management of the school, it was decided to involve the whole syndicate. The school felt that involvement in the research was important professional development and could be used as a way for teachers' to reflectively inform their instructional practice. The school also felt that as all the teachers were working in a collaborative space and already sharing planning, ideas and resources the involvement of all the teachers would lead to consistency of practice and less disruption to established routines. The teachers in the study previously had all been involved in professional development involving developing culturally sustaining pedagogy (Paris, 2012).

3.42 The classroom context

Within a DMIC classroom, the teachers and students work in a reciprocal relationship. Students work collaboratively in multiple ability groups and the focus of the lesson is not on the answer but on mathematical practices. Students are encouraged to make conjectures, develop mathematical explanations, justify their thinking, represent their thinking in a variety of ways, construct viable arguments using mathematical language, and to generalise the mathematical ideas that they develop. As well as socio-mathematical norms, (Yackel & Cobb, 1996) the teacher and students also negotiate social norms, which are the expectations that the teacher and students have for one another during discussions. Norms of this type are, however, general classroom social norms that apply to any subject matter area and are not unique to mathematics, (Yackel & Cobb, 1996).

3.43 Structure of the learning sessions.

In all the learning sessions, the students began as a large group where the mathematical task was unpacked and discussed. Social and Socio-mathematical norms were co-constructed by the students and the teacher. The students then worked in small groups collaborative problem solving for 15 to 20 minutes before returning to the larger group setting for a further 15 to 20 minutes. In this concluding session students shared problem solving strategies and ideas and the teacher then linked thinking towards big mathematical ideas and social justice goals.

The teachers went into these sessions with clear achievement objectives in mathematics and in social justice taken from the New Zealand Curriculum, Ministry of Education (2007). The teachers had also anticipated how they thought the students would solve the problems and had planned for what mathematical ideas they thought would come out of the session. The achievement objectives and big maths ideas, however, were

not shared with the students prior to the problem solving, as the teacher wanted the students to drive the learning. The teacher was interested in what the students thought and did not want to influence that thinking or prevent critical exploration by limiting the breadth and depth of questions and, consequently, of learning.

3.44 The Research Study Schedule

This investigation was conducted over a five-week period from November through to December 2019. The researcher already knew the teachers involved in the study in a professional capacity, so time was not required to negotiate social relationships.

Preliminary Phase

Initial contact as well as the majority of subsequent contact with the teachers was made *kanohi ki te kanohi* (face to face). As the current study utilised a Talanoa research methodology it was important that where possible communication between the co-researchers in the study was conducted face to face. Vaioleti (2006) asserts that Talanoa is a personal encounter where people story their issues, their realities and aspirations. Talanoa is a derivative of oral traditions and can be referred to as a conversation, a talk, an exchange of ideas or thinking, whether formal or informal and it is usually carried out face-to-face.

From a Māori perspective *kanohi ki te kanohi* is an important cultural practice that demonstrates commitment to a whanau, to a place and to a kaupapa or purpose (O'Carrol, 2013). *Kanohi ki te kanohi* is about a physical presence as well as relating to *mana tangata* (status) and a person's credibility in words, actions, or intentions. *Kanohi ki te kanohi* provides people with a sense of honesty and truth and gives *mana* to ones *kōrero* (words, talk).

In this initial contact, the researcher outlined the study, answered questions and sought written consent from the co-researcher participants as well as negotiating a time to come back to collect written consent forms, a written outline of the study and to collect baseline data about their current understandings about Teaching Mathematics for Social Justice (TMfSJ).

Phase One

In Phase One the researcher collected written consent forms (Appendix A) as well as discussing the initial word problem and associated planning, provided by the researcher (Appendix B). The researcher also had the teachers complete a questionnaire (Appendix C) in order to collect baseline data about their prior understandings of Teaching Mathematics for Social Justice (TMfSJ).

Phase Two

The six teachers involved in the study taught the first lesson. Two of these lessons were observed by the researcher and videotaped using multiple cameras. Multiple cameras were used in order to capture teacher actions as well as student conversations and teacher student interactions. The researcher also took field notes during the lesson. At the completion of the first lesson, the teachers and students were engaged in an open-ended discussion about the lesson and in the case of teachers' critical reflection and a discussion of next steps occurred. Semi-structured questions (Appendix D teachers) and (Appendix E students) were used to start as talking points that the Talanoa then flowed from and were deliberately open-ended to allow for the participants own interpretation of them. Subsequent talking points were not determined in advance but depended on the way in which the Talanoa developed. Vaioleti (2006) asserts that the Talanoa will end

when it loses its malie⁴ or starts to revisit areas covered already, since then it is probable that no more new points will be added to those that have been co-constructed. It is a respectful, reciprocating interaction. Talanoa is a good conversation: one listens to the other. When to speak and what one says depend upon what the other has to say. Classroom artefacts (photographs of student work) were also collected.

Phase 3

A meeting was held with the teachers to discuss how they felt the first lesson went. This was examined in terms of mathematical achievement objectives as well as social justice achievement objectives. The teachers experience of the lesson was also discussed including any challenges they felt had arisen and any future challenges they could foresee. The second problem (Appendix F) was then planned collaboratively and student responses anticipated along with ways to overcome challenges.

Phase 4

The six teachers involved in the study taught the second problem and two of the lessons were observed and videotaped by the researcher using multiple cameras. A third lesson was videotaped, but not observed. At the completion of the second lesson the teachers and students and researcher engaged in a discussion about the lesson and in the case of teachers' critical reflection and a discussion of next steps occurred. This also involved planning lesson 3 (Appendix G)

⁴ In Tongan and Samoan Malie is a state when reached; the psyche and spirit of both a performer and storyteller energise and uplift to a positive, often sensual state of connectedness and enlightenment (Manu'atu, 2002).

Phase 5

The six teachers involved in the study taught the third problem and two of the lessons were observed and videotaped by the researcher using multiple cameras. As with the previous lessons, the teachers and students and researcher were involved in a discussion about the lesson afterwards. Questions raised by the students during the lesson regarding what the data may look like in the future determined the nature of the fourth problem (Appendix H).

Phase 6

The fourth problem was taught, and discussions took place at the completion of the lesson.

Phase 7

The first problem (Appendix I) was retaught with the focus on percentage increase over time for the various ethnic groups as opposed to a statistics focus. Final discussions were then done with the teachers involved in the study about what they had learnt over the course of the study.

3.5 Data Collection

Qualitative data is collected from a variety of actions. These include observations, interviews, gathering and studying classroom artefacts, and using intuition to examine and interpret the social relationships amongst participants (Yin, 2011). Yin (2009) asserts that no one type of data collection method has complete advantage over another. Within this case study design, the researcher collected data from a variety of sources. By making use of numerous methods of collecting data, rich and distinct forms of information are produced (Lodico et al., 2010; Merriam, 1998).

Data collection tools utilised in this project were a questionnaire, video recorded observations of the lessons, interviews, classroom artefacts, and detailed field notes (commentaries of the lessons observed and reflections on the interviews). All of the data collected was triangulated in order to verify findings and to ensure the validity of the project.

3.51 The Questionnaire

In order to gather baseline data about the teachers' prior experience with teaching mathematics using social justice themes and to find out their existing beliefs about (TMfSJ) a questionnaire (Appendix C) was used two weeks before the first observation was conducted. The teacher participants were given the same set of questions to answer. The researcher met with the teachers to answer queries about the questions but there was no direction as to how teachers should answer apart from emphasising that the questions would provide a starting point for the research. The questions were open ended to allow the teachers' stories to be heard.

Bicknell (1998) asserts that the advantage of questionnaires is that they are easy to administer and standardised as well as possibly eliciting more honest responses than from an interview. Ackroyd and Hughes (1981) however argue that as the information is not gathered face to face non-verbal cues are not present meaning that there is no way to tell how truthful a respondent is being. Questionnaires permit respondents time to consider their responses carefully without interference from an interviewer but often there is no strong motivation for respondents to respond so it may be difficult to obtain a good response rate or to obtain a response prior to the research starting. This can lead to a tainting of the data and because of this; the quality of data is probably not as high as with alternative methods of data collection, such as personal interviewing.

3.52 The Interview

One of the most effective ways to gain an understanding of the participants in a study is to conduct an interview. The interview is a powerful data gathering method employed to develop an in-depth understanding of participants' perceptions and beliefs in a case study. Interviews are used to collect descriptive information in the participants' own words (Berg, 2009; Bogdan, Knopp & Biklen, 2007). The aim is for the researcher to be able to understand the world of the participant, and to test, expand on or confirm intuitions (Walford, 2009; Willis, 2008; Yin, 2011). To assist analysis of data all the interviews were recorded and wholly transcribed. The interview can be classified into three categories: structured interviews, semi-structured interviews, and unstructured interviews (Fontana & Frey, 1994).

The structured interview is planned with questions and responses which are pre-set before an interview takes place. As this type of interview adopts a standardised nature, flexibility with this approach is non-existent. In contrast, unstructured interviews use open-ended questions and the approach is non-standardised. Specific questions commonly develop during an interview and general questions may be used to help direct the interview (Fontana & Frey, 1994). It is important to note that although there are different interviews a researcher can conduct; it is paramount that the interview approach is selected based on research questions and purposes (Punch, 1998).

King and Horrocks (2010) identify three types of interviews. Realist interviews are interested in neutrality and detachment. Contextual interviews are concerned with the context of the interviewee's experiences and the subjectivity of the interviewer and constructivist interviews involve the co-construction of meaning by the interviewer and

the interviewee together. In keeping with the kaupapa⁵ of Talanoa, the interviews were semi-structured or unstructured as well as being constructivist in nature.

The student interviews were conducted in small groups. The role of the researcher changes in group interviews functioning more as a facilitator than an interviewer (Punch & Oancea, 2014). The group interaction is directed by the questions the researcher asks and the researcher moderates and records the discussions that occur. The use of group interviews for the students was chosen for a variety of reasons. Firstly, time constraints meant many students needed to be interviewed in a limited amount of time after the lesson occurred so by seeing the students in small groups, we were able to gather more voices than if the interviews were conducted one on one. Secondly, the researcher felt that by interviewing in small groups the students would feel more relaxed than in a formal one on one interview increasing the chance for a more authentic voice to come through. Thirdly, it was thought that the use of small groups would allow the Talanoa to develop as the students responded to each other as well as to the questions being asked.

The teacher interviews were mainly conducted one on one although some group interviews did occur during planning sessions as well as at the completion of the five lessons. As mentioned earlier these interviews were either semi-structured or unstructured and constructivist in nature. Unstructured interviews are in-depth explorations of interviewees' experiences and interpretations, in their own terms, (Punch & Oancea, 2014). The unstructured interview is a powerful education research tool capable of providing rich and valuable data; it requires flexibility and has many of the characteristics of a prolonged and intimate conversation. Talanoa literally means talking about nothing in particular and interacting without a rigid framework (Vaioliti, 2006)

⁵ Principles

and as such requires an unstructured interview framework in order to be successful. Talanoa allows people to engage in social conversation, which may lead to critical discussions, or knowledge creation that allows rich contextual and inter-related information to surface as co-constructed stories. The patterns identified in the earlier interviews were used to refine the questions in later interviews in order to extend the Talanoa. All the audio interviews were transcribed (Creswell 2007) by a professional transcription service and then checked by the researcher.

3.53 Observations

Yin (2011) asserts that observations are considered a form of primary data for qualitative researchers. As a data collection technique observation, like interviews can, to varying degrees be structured or unstructured (Punch & Oancea, 2014). Punch and Oancea assert that qualitative approaches to observation are much more unstructured and open-ended. They are without predetermined categories and classifications. The observations in the current study were un-structured.

The role of the researcher and the purpose of the observation was known to the teachers' involved in the study and were mainly non-interventionist in nature. The students' behaviour being observed was left to naturally unfold although the researcher at times did reflect in the moment with the teacher about what was being observed and the challenges that this may present. Field notes were taken during the observations and these were later used as a starting point in teacher researcher, researcher discussions as well as planning sessions. Field notes also formed the basis of starter questions for the Talanoa with students and teachers.

During this investigation, observations were video recorded using multiple cameras with multiple observers, with the aim of capturing as much of the teachers'

interactions with students' as well students' conversations and behaviour with each other. Due to the amount of material video recorded, some of it was not relevant to the study so only relevant parts were transcribed and non-verbal cues noted. Through transcribing the video-recorded lessons, the researcher was also able to reflect retrospectively on what had occurred in the setting. Relevant episodes of interest were analysed directly from the footage, through repeated viewings, with a focus on student and teacher discussions and understandings about the social justice and mathematical achievement objectives planned for in the lesson. Themes and patterns that emerged from the videos were noted for further analysis.

The video-recorded observations were also used to corroborate field observational notes as well as the audio recorded interviews, and classroom artefacts. Field notes provide important context to the interpretation of the video-taped and audio-taped data and can help remind the researcher of situational factors that may be important during data analysis. The classroom artefacts collected included photos of the mathematical work and social justice statements students did in their small groups as well as photos of the whole class mathematical findings recorded in the context of teacher facilitated discussions, and copies of the planning.

3.6 Data Analysis

Merriam (1998) asserts that the aim of analysing data is to make sense of it. This aligns to Glesne and Peshkin (1992) description of data analysis of meaning-finding interpretations and judgements in a complex process of sense making. Glesne and Peshkin caution researchers to be wary of the desire to justify their own experience or allow emotional attachment to "preclude the open, exploratory learner's attitude that is necessary for good data collection and analysis" (p. 14). Punch and Oancea (2014) assert

that there is no single right way to do qualitative data analysis and no single methodological framework due to the variety and diversity of qualitative approaches. Sutton and Austin (2015) argue that the most important part of data analysis and management is to be true to the participants. It is the participants' voices that the researcher should be hearing, interpreting, and reporting on, for others to read and learn from.

Talanoa belongs to the phenomenological research family, (Vaioliti, 2006). Phenomenological research approaches focus on understanding the meaning that events have for participants so it was important sense making occurred from the participants' perspective so that the research would be useful for them. Talanoa's philosophical base is collective. Analysis of data therefore had to focus not just on the challenges of TMFSJ but also on the ways, these challenges could be overcome.

Qualitative data analysis progresses through revisiting data and connecting it to emerging insights and refining understandings and focus (Srivastava & Hopwood, 2009, as cited in Punch & Oancea, 2014). This is done by iteratively asking what does the data tell me, what do I want to know and how is it linked. The video and audio recordings transcriptions were read, re-read, and revisited many times in order to identify themes. The video footage was watched and re-watched, so that social interactions could be clarified and to identify links to the student and teacher audio interviews. An on-going process of analysis of transcriptions and observations was undertaken and contrasting statements that the students made in small group video observations compared to what they said in interviews was noted.

Patterns were captured and categories generated to allow for coding of the collected data and to lead to a comprehensive and detailed description of this case.

Themes were then examined against the assortment of collected data; including the classroom artefacts, field notes and teacher reflections.

3.7 Ethics

The current study upheld the Massey University's Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants (2015) which guided the ethical principles considered during this case study. The ethical standards include key principals of informed consent, and written consent was obtained from the teachers, the students and their guardians-as the students were under the age of 15 years prior to the study commencing (Appendices A and J).

The ethical standards also included respect for persons, minimisation of harm to participants, researchers, institutions and groups, respect for privacy and confidentiality, the avoidance of unnecessary deception, avoidance of conflict of interest, social and cultural sensitivity to the age, gender, culture, religion, social class of the participants and justice.

This study however included some ethical dilemmas, which are reportedly more problematic in qualitative case study research, (Merriam, 1998). Privacy and confidentiality within the classroom and between participants was difficult as the students and teachers were known to each other and to the researcher. All practical steps were taken to ensure the anonymity of the participants and the school. Pseudonyms for students and teachers were used at all times and participants, the researcher and others that had been clearly identified prior to consent being obtained only viewed video footage.

Another ethical dilemma was the potential conflict of interest from a Eurocentric point of view between the researcher's roles in the research project and the researcher's job as a mathematics mentor where they have been an active participant in the classroom.

The researcher has tried to minimise the potential conflict by declaring the relationship and explaining the researcher's role to the different parties involved. Within a Pāsifika world view when conducting Talanoa this close relationship would be seen as a positive. Vaioleti (2006) asserts that historically research interactions have not required a personal relationship between the researcher and the participant in order to obtain information. The interactions were guided by approved ethics but these are based on different thinking from that of Pacific peoples. The disparity between the objectivity base of much traditional research and the subjectivity of the participants is often not recognised in Pacific research contexts.

The researcher therefore needed to negotiate this dichotomy between objectivity and subjectivity. The mutual trust and reciprocity inherent within Talanoa that allows for the talk and exchange of ideas to come through needed to be balanced against the potential for the researcher to unduly influence the outcomes of the Talanoa. It was important to maintain the personal relationship because relationship is the foundation on which most Pacific activities are built (Vaioleti, 2006). However, the researcher (during the teaching episodes) needed to withdraw the advice and guidance they would normally have offered through their role as a mentor. If they had not done this, it would have created a power imbalance that could have led to the researcher deciding what constituted the narrative as opposed to providing the opportunity for the participants Talanoa to be heard.

3.8 Summary

A qualitative research design was selected as the most appropriate method to obtain data and provide answers to the research questions in this study. The researcher collected data from multiple sources over a five-week period. These included a

questionnaire, semi-structured and unstructured interviews, video observations, field notes and classroom artefacts. Data was analysed using a grounded approach of identifying codes, categories, patterns and themes.

To ensure the reliability and validity of this study so that the participants Talanoa would be heard, the researcher attempted to find a balance between the academic ethical considerations and the collective ethical principles contained within Talanoa. Above all else, the researcher throughout this investigation sought to ensure that no harm would come to any of the participants and that their mana⁶ would be maintained. The findings and discussion of this investigation are reported in the ensuing chapters.

⁶ status, spiritual power

Chapter Four:

Thesis Findings

4.1 Introduction

The previous chapter outlined the design and methods used in the study including discussing the data collection methods used in this investigation. This chapter will analyse the data collected over the course of the study. The data will be analysed in terms of the challenges teachers faced when introducing a social justice focus to their mathematics programme as well as the teacher actions employed to overcome these challenges. In keeping with a Freirean perspective, themes of domination and liberation were considered in relation to the challenges encountered and discussed in the following chapter.

Section 4.2 will analyse the answers to the questionnaire that teachers completed prior to the start of the study about their understandings and beliefs around TMfSJ. Section 4.3 will look at the answers to the initial question regarding the challenges the teachers expected to face. Section 4.4 will examine the challenges that occurred and the ways that teachers worked to overcome these. Section 4.5 will look at other barriers to TMfSJ as well as affordances and Section 4.6 will summarise the chapter.

4.2 Teacher perceptions of (TMfSJ). Teaching mathematics about with or for Social Justice.

Section 4.2 will examine the teachers' perceptions of TMfSJ two weeks prior to the beginning of the study. The initial activity all teachers participated in was the

completion of a questionnaire that sought to explore their prior experience with TMfSJ, and understandings and beliefs related to TMfSJ.

All six (n=6) teachers had had experience to varying degrees of culturally sustaining mathematics and culturally sustaining pedagogy in general. They all drew on the lives and cultures of their students when planning mathematical problems and were involved in on-going professional learning and development in mathematics and culturally sustaining pedagogies. Five (n=6) did not see this earlier work as directly related to TMfSJ as one teacher stated:

No, I have not used a maths question that looked at Social Justice. I have, thanks to DMIC used mathematics questions that acknowledge and are relevant to our students' backgrounds and who they are though. So far, the focus in mathematics was exactly that – Maths. Social Justice was not highlighted here, as I thought this subject would be better addressed in other curriculum areas such as English or the Social Sciences.

Clearly, she did not see that by being culturally responsive and by taking a strength-based view of her students in mathematics that this in itself was an act of Social Justice. For this teacher and others unless what they were doing was grounded in some injustice outside the classroom and in one's community, they did not see this as TMfSJ. This was evident in their discussions about how they had incorporated Social Justice into their literacy programmes. This included examining the social justice issues involved with the Dawn Raids⁷ and Parihaka⁸ with their students. In their comments, it was evident

⁷ Dawn raids were a common event in Auckland, New Zealand, during a crackdown on illegal overstayers from the Pacific Islands from the mid-1970s to the early 1980s.

⁸ Parihaka: On 5 November 1881: About 1600 government troops invaded the western Taranaki settlement of Parihaka, which had come to symbolise peaceful resistance to the confiscation of Māori land.

that social justice in mathematics for them was concerned with teaching mathematics about social justice, so the context of lessons had to explore critical social issues. However, TMfSJ also refers to the pedagogical practices that encourages a co-created classroom and provides a classroom culture that encourages opportunities for equal participation and status and the teachers had been doing this prior to the study without realising it.

One teacher did see the links between the culturally sustaining mathematics pedagogy that the school was involved with and TMfSJ. He stated that creating problems that the students could relate to, that built on prior knowledge *validated his students' identity and showed them that they mattered*. This teacher also indicated that they had engaged in prior teaching of mathematics through a social justice lens.

Last year I used some word problems that examined the interest rates of finance companies that offered high interest short-term loans to people that lived in the community that the school was located. The kids were able to see just how much interest they had to pay the finance company back and that it ended up more than the amount they would have borrowed.

From this statement, it is evident that this teacher was teaching mathematics with social justice and about social justice. Through this, he was also providing opportunities for his students to develop a critical consciousness. The teacher stated that time constraints and the need to cover the maths meant that he did not deepen the social justice component of the lesson. Therefore, the students were not given the opportunity to develop informed action or praxis.

In the next section teacher responses to their initial understandings of TMfSJ is explained.

4.21 Social Justice Understanding

All of the teachers (n=6) had some understanding about what Social Justice within education looked like. For example, one teacher stated that *Social Justice in education is about fairness* and another stated that it was about *ensuring that all students receive quality education regardless of their socio-economic status and education [and] should be provided without bias*. Two (n=6) indicated that our current education system failed to achieve social justice and was structurally unfair to the students that they taught. The teachers comment about equity indicated they were actually talking about equality and the notion of being fair and treating everybody the same; rather than recognising that equity would require ensuring that everyone needed different opportunities to ensure success.

All of teachers believed that social justice had a place within mathematics. One teacher commented, *“Students’ will come to a better understanding of the world around them by doing mathematics that looks at social justice”*. Another teacher said, *“If social justice is included students will not only learn skills, strategies and knowledge, this will simultaneously assist students in making informed decisions to take actions that promote and encourage equity”*. These statements indicated that the teachers were aware of the role of social justice problems as a tool, which students could use to read and understand the world they lived in. However, it was evident that most of the teachers had limited experience in and understanding of TMfSJ beyond thinking about the concepts of fairness and equity.

The teachers identified many social justice issues present in the community that affected the lives of their students. They commented on access to housing, health, unemployment, high crime rates, gangs, low incomes and job insecurity, stereotyping,

and limited resources. At this point, nobody described the socio-political causes of these issues or the impact that they had on education. All the teachers commented that they were open to learning more and they were deeply committed to providing opportunities for all their students to learn.

The next section will examine and explore teachers' responses in an interview prior to the first teaching episode. Explanations will be provided of their perceptions of potential challenges, which emerged, from the Talanoa, which developed in response to the open-ended question.

4.3 Teacher perceptions of potential challenges in TMFSJ

Four of the teachers (n=6) thought that there was a possibility that a focus on Social Justice may have a negative impact on the learning of mathematics. The teachers discussed concerns about coverage. They indicated that too much time spent on social justice issues might mean they were not be able to cover the curriculum. They voiced concern that the mathematics might get lost and that the students may not realise what they were doing was mathematical. For example, one teacher stated:

At the end of the day, it is mathematics, and the focus should be mathematics as that is what they will need at college.

Another teacher explained: *I think it could be good to do some but when you only have an hour for mathematics, you do not have a lot of time for talking about other things.*

Two teachers (n=6) stated that including social justice would enhance mathematics learning by making it genuine and experientially real. At this point in the study, it was evident that only two teachers perceived value in TMfSJ.

Five of the teachers (n=6) to varying degrees voiced their concerns that by examining statistics that looked at inequity the students may take on a negative view of themselves and develop a sense of hopelessness. One teacher had no concerns that TMfSJ would detract from the mathematics, or that the students may develop a sense of hopelessness. She stated: *No, I really think the kids will get into the mathematics more because it relates to them and their future. This stuff is the reality for our Pāsifika kids, so we need to show it and say hey how do we change this.*

When exploring possible word problems, no teachers however were prepared to present problems concerning prison statistics and four indicated their hesitancy about looking at life expectancy data. For example, one teacher explained:

Yeah, I would be a bit worried about looking at prison stats as that is a bit too close to home for some of our kids. I know that our justice system is biased and that you are more likely to go to prison for the same offence if you are brown compared to if you are white but I am not sure, like it might make the kids feel stink about their culture. I do not know about that one.

It appeared that the teachers were willing to look at problems concerning social justice as long as they were not too controversial.

The teachers felt that if they chose topics that were too controversial that this may create friction with senior management and or the whanau (family) of their students. One of the teachers went to talk to the Principal prior to the first lesson as he felt some students might see the inequity in hourly wages linked to racism and he wanted to keep his principal informed. He said:

I let Steve know what we were going to do as I think the kids are going to see the racism and that New Zealand is racist because Māori and Pāsifika

earn less than Pākehā. I did not want him to think I was pushing some kind of socialist agenda if he heard it through someone else. He was fine though.

This was an example of what teachers perceived as a challenge (Disapproval of Senior Leadership) not being the problem they thought it would be.

In the next section, the challenges the teachers identified as they engaged with teaching Mathematics for Social Justice are outlined. The themes in this section, which related to the teachers' internal and external struggles, were developed through analysis of subsequent teacher and student interviews, video recorded classroom observations, field notes and classroom artefacts.

4.4 Challenges to Teaching Mathematics for Social Justice.

This section will analyse the challenges that teachers encountered when TMfSJ. Many of the challenges identified by the teachers prior to the study were due to internal perceptions about expectations on them that were not necessarily correct. These included school management expectations, whanau expectations of what mathematics should like; and the 'need to cover' the mathematics curriculum. Despite this, they still had an impact on the teachers' willingness to explore the social justice issues identified by students. The other challenge that presented was the students own internalised oppression. Only two teachers had identified this as a potential challenge in the initial talanoa.

This section will address the challenges that teachers encountered in terms of their own and students' beliefs and perceptions in relationship to TMfSJ.

4.41 Student beliefs and perceptions

Clearly, from all observations the students had an understanding of inequity and a sense of fairness. However, they also provided a challenge to the teachers of how to move them past a sense of resignation towards the inequities they had encountered. In many cases, the students voiced an acceptance of the blame for their oppression rather than recognising the inequities and suggesting ways to change the system. It was evident from the video-recorded classroom observations that the students also showed an initial reluctance to share their ideas about the reasons for inequity with their teachers. From the initial classroom observations, students talked about equity issues in whispers but tended to stop when adults approached the groups. This behaviour reduced over the course of the study.

4.42 Teachers and students' interactions around internalised oppression

In the first lesson observation, which related to a graph [See appendix B], which showed hourly pay and ethnicity the students, noted that Pākehā⁹ men earned more than other ethnicities. Pākehā women followed that and that disparity occurred based on gender and ethnicity. The students were able to access the mathematics. They compared the pay of men in relationship to women as well as across ethnicity and were able to articulate the inequities within the data. They also recognised that the gap between the groups had increased over time and mathematically were able to use the data to predict future trends. For example, when interviewed a student said he had learnt:

How unfair it is between us Pacific Islanders and Pākehā. Pākehā get paid way more than us Pacific people, especially when we are working hard

⁹ Pākehā is a Māori-language term for New Zealanders primarily of European descent.

and as much as them. It also keeps getting worse. The gap is getting bigger and will keep getting bigger if nobody says something.

When asked if NZ was a fair country the student replied:

No, because us islanders try to get the same jobs as Pākehā people, but we don't get that privilege, I think that it might be racist

This student's response indicated that they recognised that what they experienced was racism. The statement also indicates their recognition that something needed to change.

In contrast, another student when questioned about if NZ was a fair country replied:

Kind of, kind of, yeah, people judge women and they say that women cannot really do things that men do, so probably that is why they are not paid more like the men and Pākehā do jobs that are more responsible so they should get more.

This student's response indicated an acceptance of inequity.

Internalised oppression was a common theme across the student interviews. Commonly they made statements about the inequities. They extended these statements as largely accepting them and indicating beliefs in a meritocratic illusion that if you worked hard you would succeed and if you failed to succeed that was your fault.

Internalised oppression was also evident in observations of small group discussions during the mathematics lesson. Some students' comments indicated that they perceived inequity as a natural thing because in their opinion Pākehā work harder or lived healthier lives. These views resulted in collaborative debate and argument as shown in the following discussion.

Luseanne: *Hey Pākehā men are the top and Pacific woman are the bottom and it is getting worse over the years.*

Kalo: *I think it is stink. Why are they getting less? We are all the same. Pāsifika woman are working very hard for their money and should get paid the same as Pākehā men*

Malakai: *I disagree because we do not know if they are working hard enough. Pākehā work hard and do hard jobs and they have been here longer than us.*

Luseanne: *What about Māori they have been here the longest and they do not get as much as Pākehā. We live on Māori land so they should get the most.*

Kalo: *(whispering) I think it is racist.*

Malakai: *Nah, it is not racist. It is fair as they work hard for it. Pākehā should get more*

These debates occurred across all classroom observations over the course of the study. This showed that some students were not prepared to accept the inequity that the data highlighted in the maths problem. However, a significant number of students voiced statements that indicated their internalised oppression.

Giving space for students to voice their opinions in an open way where there was no right or wrong supported further debate within the whole class discussion at the conclusion of the lesson. The students challenged each other's beliefs and the teacher challenged evidence of the internalised oppression of students. He began by re-voicing the student comments and linking these to the concept of fairness.

Teacher: *So, you identified that Pākehā men earn the most, that Pacific women are paid the least, and that the gap has almost doubled over the*

years. Why do you think that is? Why are Pākehā paid more and why is the gap getting bigger? Do you think that is fair?

Immediately a student introduced the concept of racism, gender and fairness.

Luseanne: *I thought it was racism and that is was not fair and that it was also not fair that women earn less.*

Another student voiced evidence of his acceptance of the status quo as being right and fair.

Malakai: *I thought it was fair because like the Pākehā work hard and have responsible jobs. Like the Pākehā might be a pilot not the bus driver or he might be the boss of the factory not the factory worker.*

In response, the first student linked her own experience with inequity to challenge the comment of the previous student although she does not suggest a solution.

Luseanne: *My Mum and Dad work hard. My Dad works 16 hours a day, why does he not get more.*

In turn, the teacher re-voices again the focus of the mathematics problem and the student responses

Teacher: *So some of you think it is fair that Pākehā and men, and especially Pākehā men are paid more and others think it is not fair.*

At this stage of the lesson, the Key Mathematical ideas for statistics had been achieved. In his summing up however, he has negated to address the social justice issues that were emerging from the student responses. The opportunity to open the discussion about structural inequity and structural racism in order to meet the Social Justice learning outcomes of the lesson was missed.

The teacher indicated in a verbal reflection after the lesson that he was aware that he had missed an opportunity to address the social justice aims of the lesson. He noted; that this was an area in which he needed to grow his practice. In common with all the other teachers, he indicated that they needed to move past a surface analysis of social justice issues. For example, another teacher stated:

On the surface, I think we looked at the social justice aims but we need to go a lot deeper in order to be critical in the other lessons. Some of the kids said it was not fair and it was racist, but we did not look at why we have this inequity or how we can change it. I thought it was a good start though.

The teacher after the first lesson has realised that they will need to push the students thinking further if they are to start thinking critically about the world around them. In the next section students, start using the mathematics to do what Freire (2000) suggests; to read the world and understand oppression although the solutions to overcome it remain internalised.

4.43 Reading the world with mathematics

The second problem, [see Appendix F] examined the minimum wage and living wage and whether this would be enough to live on in Auckland. Initially the students focus was on the mathematics in the problem. For example, one boy was explaining his thinking to the group and as he spoke, he checked understanding and answered questions.

17.5% of \$708

10% is \$70.80, because you just divide by 10, does everyone understand?

Ou te malamalama (I Understand)

Mary: *Both my Mum and my Dad have two jobs. That is why there is homelessness and like you see lots of families live in their cars at the park.*

In their statements, it is clear that these students are able to identify and make links between the social issues in their community and the injustice of the minimum wage.

The students also identified unfairness caused by stratified wage rates.

John: *That is not fair when some people are really rich and stuff and have flash as house*

George: *Pālagi¹⁰ have flash houses and flash as cars*

Another group identified the inequitable situation they knew their parents experienced as they looked at the statistical data.

Factory workers get minimum wage!

Night shift, you have to work more hours and spend less time at home.

Just go on the dole

You will be so tired.

What these students made was direct connections to the lived reality of their parents. The suggestion that getting a job with such low pay was not worth the effort indicated that they had no solution to the inequity other than resignation towards accepting the status quo.

Statements like this provided the teachers with opportunities to develop further in the large group discussion stage of the lesson. Two of the teachers (n=6) subsequently explored how the low hourly rate related to the students' lives. They asked how many of

¹⁰ Pālagi is a word in the Samoan and in other Pacific Island languages describing Non-Pacific people especially European westerners or Caucasians. In the New Zealand context, it is used to describe Pākehā.

the students had parents working multiple jobs. They then began a discussion with the students about ways this could be changed and how poverty could be addressed in New Zealand. Student responses continued to illustrate the belief that success was determined by how hard you worked at school. For example, different students said:

I think that if you want not to be on minimum wage you need to work hard at school. Because then like you will get a better job that pays more.

If you work hard at school, you can go to University and then get a good job.

Neither of these students had recognised the institutionalised racism in the schooling system, which could preclude Pāsifika achieving no matter how hard they worked.

Another student noted that:

A lot of us Pacific people we work in the factory and stuff where the pay is no good so I am going to get a better job.

Collectively these statements indicated that the students had considered only internal solutions to low wages and poverty. Within this framework it appears that they are saying that individuals are to blame for the circumstances that they are in without recognising societal causes of inequity.

Reflectively, one teacher realised that the mathematics had produced good discussion. However, he recognised the need to push further with the social justice aspect.

Really good, lots came out of it, good maths discussion, the kids were starting to make some links, yeah probably if we pushed a bit more or had more time we could have had more discussion on the social justice

side of it, but I think they made the clear connection between that's not enough money to live.

As the teacher reflected on the question, which explored how he thought the lesson had gone he began to see the need to move beyond surface analysis of social justice and dig deeper into systemic inequity.

We're getting there,they're starting to connect, what was in the data, and what we were talking about to their own situation... They are starting to see the link why you have to work more hours. So, that is why mum is always asleep when I come home and things like that; it was quite interesting. We now need to push more so it is not; I want to get a better job so I earn lots more money, so yeah I am not in that situation, rather than thinking about whether there is equity in there. Is it fair that some people have lots and some people do not have enough? Is it fair that some people have 10 houses and some people sleep in cars? It is sort of, something you have to discuss with them.

At this point clearly, the teacher is starting to realise the need to address systemic inequities that the students face. He continued then to address ways for everybody to take social action.

We need to let kids know not to accept the status quo as just the way the world is... It is kind of lighting that fire of actually you know, you do not have to put up with that. You should not have to put up with it; it is developing a sense of entitlement in a positive way, because that is often such a, put down of people. However, like our kids here, they let things, a lot of things slide, and so does the community, when they should stand

up for it and say no, if those people have this why do we not have it, you know.

At this point the teacher has realised the need for students to do what Freire (2000) says which is to not only read (understand) but also write (change) the world and that mathematics as Gutstein (2006) suggests, can be a vehicle to achieve this.

The next section will show some students beginning to shift past internalised oppression towards seeing external causes of inequity

4.44 Moving towards writing the world with mathematics

In problem three on unemployment statistics, [see Appendix G] some students continued to display internalised oppression: For example, in a small group discussion the following exchange took place:

John: *I noticed that the Pacific people and the Māori people have the highest unemployment rate*

Taniela: *Europeans have the least, lowest unemployment rate and their line (on graph) is straight*

Tavita: *These people are lazy and the European, they are not lazy they are employed.*

John: *I wonder why the European (unemployment) line is so straight.*

Tavita: *It is because Europeans are hardworking people eh. It looks like our country is lazy.*

However, another student responded with this comment:

I think the unemployment statistics show that New Zealand is a racist country.

This indicated that other students were starting to see external causes for the disparity.

In the large group discussion however, when asked for ways to change the data the students spoke again about internal solutions of working hard at school and getting a good job. Four teachers (n=6) pressed the students to explore whether school privileged certain students. Teachers with support of a teacher educator also pressed students to examine the statistical data to determine when unemployment rates for Māori and Pāsifika dropped and think about the social and political landscape at the time. This led to one student opening up the conversation about how people could potentially make change within society.

John: *I wonder why the Pāsifika unemployment rate is lower in 2017, so maybe the government policy has changed during that time.*

Taniela: *The Labour Government won the election; Labour are better for Pāsifika people. They care about us.*

Mele: *So, who you vote for is important if you want to change things, like you got to vote.*

This discussion gave the students opportunities to make links between the mathematics and social justice. The students were able to use the mathematics to see external solutions for the inequity they encountered. The discussion also provided the teacher with evidence that students were moving past internalised solutions. In a post lesson reflective discussion, she stated:

That was a good statement because that change in government actually happened. I was impressed with the thinking of the children. They actually could make out what they were saying and they could make out the reasoning why these things took place and why the things are fluctuating and not just that the things are fluctuating, but why? That moves past this understanding about the data, which is quite negative,

to actually what can we do to change that data. ... That was something that I was happy about to come out of the lesson.

This understanding about the power of voting was also evident in another classroom as this teacher explains:

They were talking about the fairness with the government and talking about the need to vote and how they could make a change and knowing how to vote, knowing who to vote for and knowing policies. Yeah, so the fairness side of it did come out. I thought it was quite important with the whole government change thing. I did highlight that it is actually having conversations with your parents and knowing for whom you are voting.

From the data it is clear that these teachers were seeing shifts in how their students both could interpret data and then use this data to consider ways to write (change) the world.

4.45 Developing critical consciousness

Providing teachers with space to critically reflect, in post lesson group and individual interviews gave them opportunities to identify the challenges they were encountering related to internalised oppression. At the same time, the teachers were noticing and responding when individual students voiced observations related to the graphs, which demonstrated their growing awareness that they did not have to accept how things were. This prompted the teachers to continue the press towards challenging the internalised oppression by pushing the students to examine their own beliefs.

The following excerpt related to the graph on life expectancy [see appendix H] demonstrates an example of this. As the students worked in their small groups' one student stated that: *Pāsifika people do not live as long as Pākehā because they are overweight and do not eat healthy food like salads....they are lazy and eat takeaways.*

The teacher listening to this exchange challenged them to consider whether this was laziness or whether this was because of the high cost of healthy food and not having the time to fix healthy meals due to working two jobs. Immediately the students reflected on the life expectancy data. They made direct links to how this graph related to the wage rates and unemployment statistics they had encountered in earlier problems.

They then began to question things at a systemic level as well as make links to their lives. As one student noted:

In the other graphs Pāsifika people get paid the least and the minimum wage is not enough money. My mum works two jobs so sometimes she gets takeaways, because she does not have time to cook for us; plus like the unhealthy food is cheaper. If everyone got the living wage things would be better.

This action was an example of the teacher pressing them to explore the data at a deeper level. As a result, the students illustrated what (Freire, 2000) considered to be critical consciousness. Without the teacher action, they would have continued to internalise the negative data. In contrast, they had begun to realise external causes of inequity.

Teacher actions supported the students to engage in debates, which included the notion of racism and the role it plays in inequity. These provided the opportunity to move the discourse from domination towards the possibility of liberation.

The following excerpt is from a classroom observation in relationship to variations in wages across ethnicity as a percentage [see Appendix I]. In the following small group discussion a student states:

John: Pāsifika women got the least in 1996 and they still have the least in 2016

Adam: Shouldn't they all get paid equally? Everyone should be like one line

John: How about Pākehā men, they get a lot.

Joseph: Pākehā have better jobs and the boss might be the same colour as them. The Pākehā are the bosses and they get paid even more so that they are the bosses

Tavita: That is selfish and racist

Here the students are indicating the inequity in the data and exploring it. Another student intercedes with his own internalised oppressive belief:

Joseph: No, it is fair that Pākehā get more. If you work hard, you should get more

Immediately, another student who had initially suggested the unfairness of the situation challenges this. He is now directly making links to institutionalised racism inherent within colonisation:

Tavita: No, it is racism. I get it now. See Pākehā, you know white people get more than black people and the Asian men and women are white as well. It is like the England Empire control the most of the....whole of the world. The Pākehā get paid way more and like the Māori and Pāsifika only get paid a little bit, see racism. They cheaters, racism.... I think...

The teacher then intervenes in the conversation pushing for justification:

Can you justify why you say it is racism?

The student responds:

The racism because the Māori earn less. Pākehā are getting paid more than Māori and Pāsifika. Pākehā get paid more than what they deserve, more than other cultures or something, more than other races, racism, racist,

racism. I do not even know how to spell racism. Māori should get more because they the ones that own the country.

At this point John who had been only commenting on the data in the graph builds on what Tavita has said to make links to constitutionalised rights of the Māori people

John: *Yeah and the treaty of Waitangi*

Joseph is still holding to his personal beliefs about meritocracy:

Joseph: *But if you work hard, you should be paid more and like if you do not do good at school then you don't get a good job, and Māori and Pāsifika struggle at school*

The teacher responded to this statement by challenging the legitimacy of meritocracy:

Do Māori and Pāsifika struggle at school, or do schools struggle to meet the needs of Māori and Pāsifika students?

At this point, the teacher moves to another group leaving behind the possibility of pressing the students further. However, the teachers were now better prepared to challenge the thinking when it occurred and support the students challenging deficit stereotyping.

The sophistication of the argument has improved, so that they are thinking about it beyond ... it is one thing to say ... Pacific people haven't achieved at school and that's what is holding them back...instead of just saying that's true and yeah, the lack of qualifications holds you back, the why can change it. The why can be internalised and say – because they are lazy and they muck around. Alternatively, they are starting to go, hang on. We keep looking at statistics and it is the same picture. That is not true, we do work

hard, we are not lazy so what else is going on and how do we change the picture?

At this point teachers realised the empowerment potential of (TMfSJ) through the development of their own and their students' critical consciousness.

In society at large, we kind of say there is a disconnect which is individuals are failing because they don't work hard etc. Where these children are living it and saying no, we can learn whatever you want us to and we want to, but the way we have been taught it and the way it is set up, we can't do it. You need to change the way you teach.

Over the course of the study, the internalised oppression of the students continued to be a challenge, but teachers also developed ways to support students to examine their own beliefs in a critical way. The next section will look at the other challenges to TMfSJ that teachers anticipated would occur.

4.5 Barriers and Affordances

Prior to the study starting teachers anticipated that along with internal classroom challenges from students there would also be challenges to TMfSJ related to the nature of schools and on what they believed society expected of teachers when teaching mathematics. These challenges included parental and management expectations as well as expectations of what a mathematics lesson should look like.

4.51 Expectations of Senior Management

At the beginning of the study, five of the teachers (n=6) identified expectations of the senior management of the school as being a potential challenge to (TMfSJ). They saw

this as a barrier. The sixth teacher thought management would be supportive of the work and that turned out to be the case.

The Principal's response indicated that he saw real value in highlighting the inequity that the students faced. He commented that:

Anything that comes out the teachers will be able to handle, as they understand the kids and their lives.

His comment showed that he had faith that the teachers would understand the reality of the students' lives, treat the lessons with sensitivity and respect, and support the students in a way to help them see past the negative data towards positive solutions for change. The Principal prior to the study was already progressive and supportive of culturally sustaining pedagogy. His school had been an early adopter of (DMIC) and he has over the years been a strong advocate of the culturally sustaining work that we do. His comment indicated that this thinking also extended to TMfSJ.

This, however, may not have been the case in other schools with more conservative management teams. Even though in this study the teachers' concerns were unfounded in other schools they may have been entirely justified.

4.52 Whanau expectations

Five of the teachers (n=6) had initially thought that the controversial nature of the statistics may upset the whanau/aiga/family or that family may see the social justice aspect of the lessons detracting from the mathematics and their expectations of what mathematics should look like. Like the concerns regarding senior management this turned out not to be the case at this school. Many students discussed what they had learnt with their families and their families were supportive of the school challenging the inequity that they themselves had faced. The following comment from one of the students involved

was indicative of the response many students received when discussing the learning at home.

Tara:

I told my mum about like the difference between the cultures and the genders and about how the teacher told us that a man and a woman could be doing the same job but a woman could still get paid less just for being a woman. My mum said it's true, it's sad but true, she said she's seen it happen you know especially with you know she's a single mother... She just told me that even though the chart could see that I could be the lowest I should still try to make my own chart. Like, just because it says I am on the bottom does not mean that I have to be.

This mother's comment showed that she thought the school; by giving her daughter, the opportunity to examine inequity critically also afforded her the opportunity to overcome it.

The student went on to say:

Tara:

Mum said that it is good that we are learning about this stuff at school because there are lots of things not fair, but you don't have to accept that. Even though it is a problem that Pacific women earn less when you see a problem, you have to not just be sad about it you got to recognise it and see how you can find a solution. Like if people are telling you oh yeah, you are going to get paid less in the future you do not just go oh okay you go and you try to like work for more.

It was evident from this parent's comment that she saw the learning her child was involved with as valuable as it was not only teaching her about the way the world was but was also presenting an opportunity to do something about it. The lesson was teaching mathematics but also teaching resilience at the same time as developing what Freire (2000) referred to as a critical consciousness. This parent clearly saw the potential for these discussions to support her daughter to change or write the world she lived in.

Even though at this school parents were supportive of TMfSJ, this may not have been the case in other schools. Many of the parents had experienced inequity and racism in their lives and wanted their children to be equipped to deal with these things. They saw that teachers critically discussing these things with their children as a way to achieve this. At other schools where parents may have not had experience of, or even acknowledge racism in New Zealand, they may not have been as accepting of having their children exposed to this reality.

4.53 What about the Mathematics?

A big concern for four of the teachers (n=6) going into study was that a focus on social justice issues might detract from the students learning of mathematics. They made comments like what this teacher said:

I am a bit worried that the mathematics will be lost if we talk too much about social justice and that we will not have time to cover everything.

This however, turned out not to be the case with all teachers (n=6) saying that most students either met or exceeded the mathematics achievement outcomes set for the lesson. They also noted that those that did not meet the objectives were working towards them and had come away with new learning.

One teacher commented that she had never used real data before and that the depth of the analysis that came out of the lessons was far greater than she had experienced in other statistics lessons. Her comment was indicative of what all the teachers were saying.

This teacher said that:

The use of real data in the graphs and problems linked to the students' lives resulted in greater engagement and deeper thinking. The statements they made were at a deeper level when doing the analysis. They started to think more about how things would look in the future, which I had not seen them, do before... They compared the data across the graphs from the different problems and I have never seen that... They talked about how the wages data and unemployment problem and the life expectancy data were all related. We wanted them to make comparative statements and they were doing that across data as well as within data so that was really good,

This teacher had been hesitant to introduce TMfSJ but could see from the student responses that the mathematics objectives were achieved and that the students were taking the learning deeper than she had previously seen. In the living wage versus minimum wage problem [see Appendix F] she commented that: *by using the actual wage rates and tax rates the learning was real and engagement was higher as kids were asking is this real and then actually realising that the minimum wage was not enough money to live on.*

Instead of detracting from the mathematics this teacher' comments indicate by teaching through a social justice lens that the mathematics had been enhanced.

4.54 Teacher content knowledge (Mathematics/TMfSJ)

The word problems used over the course of the study were provided by the researcher, as was the associated planning. Problems were designed with inter-connected big ideas and a trajectory of mathematical and social justice understandings in mind. Mathematics and Social Justice Achievement objectives from the New Zealand Curriculum (Ministry of Education, 2007) were included. Anticipation of student responses had occurred as well as how to connect student thinking to the objectives.

The initial idea had been to provide the first problem and associated planning. The second lesson was to be collaboratively planned with the teachers, using a problem provided by myself. The remaining lessons were to be planned, by the teachers. This occurred for lesson two but for a variety of reasons the teachers did not plan subsequent lessons. This can be attributed to the internal challenges that teachers faced when TMfSJ and in particular their own mathematical and social justice content and pedagogical knowledge. Some teachers expressed a lack of confidence in their mathematical knowledge and others in their knowledge of the social issues that their students faced. Only one teacher (n=6) expressed confidence in planning an integrated unit of work.

All the teachers (n=6) however, were open to learn more but time became a factor. Collaboratively planning the problems would have supported teachers to develop their own knowledge but due to the short lead in time and short duration of the study, this did not occur to a suitable level.

The collaborative planning session for problem two [see appendix F] and the reflective discussions after each lesson did grow the teachers' ability to make links across the questions and link the mathematical goals to social justice goals. However, without teacher educator instruction teachers did not dig deep enough into the mathematics or

into ways the students could effectively challenge structural inequities and structural racism in society in order to (write) change the world. This is an area for future development.

4.6 Summary

This chapter began by analysing the teacher questionnaire and the initial research question that sought to establish teachers prior experience with TMfSJ as well as the potential challenges that teachers expected to encounter when TMfSJ. The actual challenges that teachers encountered of which internalised oppression was the main overarching challenge was then examined and the pedagogical actions teachers took to overcome these challenges was analysed. The chapter also looked at other potential barriers to TMfSJ and the impact that they had on this case study. The findings were presented in themes, related to domination and the potential for liberation that emerged through analysis of the transcriptions. Participant voice was presented to provide authenticity and evidence.

Although some of the challenges teachers thought, they would encounter when TMfSJ, did not eventuate in this case study, they are still included as they potentially are still internal barriers that teachers have to overcome. In other schools with more conservative management teams and parents from different backgrounds to the case study school, they could well have been major barriers to TMfSJ. In the next chapter, the above findings are discussed and links to literature are made.

Chapter Five:

Discussion and Conclusion

5.1 Introduction

The previous chapter analysed the data collected over the course of the study. Challenges to Teaching Mathematics for Social Justice (TMfSJ) both perceived and real were analysed as well as the pedagogical actions taken by teachers to mitigate these challenges. This chapter will discuss the findings and the themes that emerged from them and make links to the literature.

Section 5.2 will look at the challenges to TMfSJ that internalised oppression presented. Student perspectives and how these were transformed over the course of the study from a starting point of domination towards the possibility of liberation will also be discussed. These changes correlated to a strengthening of student identity and student agency. This occurred as they saw how they could actively collaborate in change as opposed to passively accepting the status quo. Section 5.3 will discuss the importance of reflection when considering the other challenges that the teachers faced. It examines the impact of their pedagogical actions when enacting TMfSJ to support students in reading and writing the world with mathematics. It will also discuss the opportunity to have moved student reflections and theory towards praxis or action oriented towards changing society and the reasons that this never eventuated. Section. Section 5.4 will summarize the discussion. Section 5.5 will discuss the implications and 5.6 will discuss where to next in terms of research opportunities. Section 5.7 will be the conclusion and final thoughts

5.2 Towards a Pedagogy of Liberation

Freire (2000) asserts that in order to be transformative; pedagogy must be forged *with*, not *for*, the oppressed. He argued the need to make oppression and its causes, objects of reflection, as from this reflection comes the necessary engagement for liberation. Over the course of the current study, there was a clear shift as the students moved from recognising but accepting the many inequities in their daily lives, towards a more critical stance. At the latter part of the study, they willingly challenged the inequities and their underlying causes. This was never better illustrated when a student stated:

No, it is racism. I get it now. See Pākehā, you know white people get more than black people and the Asian men and women are white as well. It is like the England Empire control most of the....whole of the world. The Pākehā get paid way more and like the Māori and Pāsifika only get paid a little bit, see racism.

This statement highlighted the significant shifts the students had made as they had interpreted the mathematics in the different graphs they had studied. The negative statistics experienced by Māori and Pāsifika, as represented in the graphs, were no longer acceptable to Māori and Pāsifika students as evidence of any internal deficit. At this point, the students were attributing negative statistics to the external factors of colonialism and racism. Such views had challenged the internalised oppression of his peers and provided for liberatory opportunities. These findings are similar to what Gutstein (2003) describes. He describes how over time the students began to raise questions about justice and equity and develop a critical consciousness through using mathematics to examine themes of race, racism, discrimination, and power.

Valencia (2010) argues that within mathematics education, statistics are often used to blame the oppressed for their failures. He suggests this leads to deficit thinking that challenges the basis of democratic education. As seen in the results of the current study, this leads to marginalised students holding deficit views about themselves and their communities, and cultures. They denounced their own cultural sensibilities and knowledge in order to emulate the dominant cultural group in New Zealand, or as Freire (2000) describes, the oppressor. By changing the focus towards a problem posing pedagogy the current study, like Gutstein (2003) previously described, had students raise questions about the inequity as opposed to answering them. This allowed them to develop social and political consciousness, a sense of agency, social and cultural identities, and meet mathematics-specific objectives.

In the current study, what appeared to shift views were the comments students made which challenged the deficit thinking of their peers. These also challenged their belief in meritocracy and thus provided opportunities to develop ways of living in a world of oppressive structures with awareness and intentionality and in doing so achieve liberatory consciousness (Freire, 2000). These results are similar to those of Hunter and Hunter (2017) where Pāsifika students initially felt the need to denounce their cultural heritage in order to be successful in mathematics. However, after being involved in a culturally sustaining mathematics programme they realised the mathematics inherent within their own culture and utilised this in order to achieve success and challenge oppression.

What was clear is that the move towards what Freire (2000) called conscientization, (critical consciousness) saw students come to understand why the world is the way that it is. This opened the way for them to begin to understand that structures are not fixed and that they are open to transformation. In the findings, it is evident that

their conversations with peers and other community members illustrated a growing awareness that they did not have to accept the statistics. Students were empowered to challenge the status quo and through reflection come up with ways they could change or write their world. This was evidenced in the discussions on unemployment. The problem-posing model of education employed in the current study led students to understand that whom you voted for could have an impact on changing inequity. They were able to see that individuals could take action to improve their situation.

The teachers were also provided with opportunities to reflect on what their students were capable of as well as reflect on the transformative potential of TMfSJ. These findings aligned to those of Planas and Civil (2009) who worked with teachers taking an empowerment perspective. Planas and Civil argued that individuals who feel they have power are more likely to contribute to actions that lead to social change. The empowerment of participants in this study did not eliminate all old practices. However, teacher empowerment through reflection directly related to the empowerment of the students and presented the possibility of liberation for both groups. This was evident in the challenges that the current study made to the deficit thinking of students and teachers. Students came to understand the external causes of inequity through the problems provided and their responses challenged teachers' beliefs about student's capabilities.

The internalised oppression exposed over the course of the study will continue to be a challenge for teachers however; by making oppression and its causes, an object of reflection the potential for liberation is possible. The next section will discuss other challenges that the teachers faced when implementing TMfSJ and the impact of their pedagogical actions on themselves and on their students.

5.3 The power of reflection in overcoming challenges to TMfSJ

5.31 Challenging a traditional narrative

Many of the challenge's teachers anticipated that TMfSJ would present on reflection did not eventuate. This however does not diminish the impact that they had on teachers going into the study. Within this study, reflection was an important component in overcoming the challenges of TMfSJ. This was especially true in terms of shifting beliefs and the empowerment of not only students but also teachers. The power of reflection by teachers when TMfSJ is acknowledged by many researchers (Baron, 2015; Bartell, 2006; Lesser & Blake, 2006; Planas & Civil, 2009; Skovemose, 2011; Wright, 2016) as a way to break down dissonance, reconsider beliefs, and gain a greater awareness of the structural causes of inequity in mathematics education.

Actively encouraging students critical questioning of social justice issues within the community using mathematics takes courage as it challenges the meritocratic myth that underpins society of which school is a part. It also challenges a conservative traditional view of what mathematics education should look like opening the teacher up to potential criticism from school leaders and the family of students (Esposito & Swain, 2009). The teachers in the current study were initially concerned with how these stakeholders would react to the study and in particular wanted to assure leadership that they were not pushing an agenda. This was one of the reasons teachers did not choose topics that were too controversial in their eyes. Teachers within the Esposito and Swain study had to navigate similar risks in not wanting their teaching interpreted as a propagandist activity attracting critique from school boards.

The findings in the current study indicate that instead of criticising the teaching of mathematics for social justice parents and school leaders were supportive of it. This in

no way however diminishes the challenge that they thought they might face or the risks they took when agreeing to take part. Guinier and Torres (2002) assert that hegemonic forces that seek, instead, to maintain the status quo, will always counter any initiative that seeks to transfer power away from those who possess it. The teachers agreed to encourage their students to question authority and question deeply held beliefs about New Zealand society and the role of schooling. This, in a school with a less progressive management team and parents with less personal experience of racism and inequity could have resulted in a different outcome. Beabout (2008) asserts that both principals and teachers need to work together to develop critical consciousness in their students. School leaders need to foster a pedagogy that will allow students to view themselves as agents in history with the ability to name and struggle against forces of oppression and support teachers to achieve this.

The study by Esposito and Swain (2009) found many educators were not prepared to take the risk, with only one participant communicating that she would risk everything in order to meet the needs of her students. All of the teachers in the current study were prepared to take a risk and through reflection, they realised that many of the things they saw as external challenges were actually internal challenges caused by their own beliefs about society and mathematics teaching. The findings of Baron (2015) who suggests that unexplored teachers' beliefs can be a barrier to pedagogical growth supports the findings of the current study.

5.32 Teaching mathematics about, with, and for social justice

At the beginning of the current study, many of the teachers had a narrow view of TMfSJ that changed through reflection over time. Initially, they did not view the strengths based culturally sustaining pedagogy they engaged in or the pedagogical practices they

used to support participation as being acts of Social Justice. For them TMfSJ had to involve an exploration of an injustice. TMfSJ therefore was teaching mathematics about social justice not teaching mathematics *with* or *for* social justice.

Over the course of the study, the teachers came to realise that the pedagogical practices that they used that encouraged opportunities for equal participation were TMfSJ. Bartell's (2006) study also found that the teacher's narrow view of TMfSJ expanded over time as they collaborated and discussed what was occurring in their classrooms. In the current study teachers began to see that the provision of a co-created classroom and a classroom culture built around respect, questioning, high expectations and risk taking were all acts of social justice. Furthermore, their belief that mathematics can and should be, taught in a way that supports all students to be successful meant students were in the position to be able to use mathematics to challenge injustice. The teacher pedagogical actions had supported the students to develop the resilience needed to keep going in the face of adversity.

The introduction of questions that explored critical social issues using mathematics (teaching about social justice) opened up the discussions and exposed the challenge of internalised oppression. However, the teacher pedagogical actions (teaching *with* and *for* social justice) provided the opportunities for students to move through the theme of domination towards the possibility for liberation.

5.33 Praxis: From Reflection to Action

Freire (2000) defines praxis as "reflection and action directed at the structures to be transformed" (p. 17). The findings indicate that reflection had enabled students to begin to understand the external causes of inequity and discuss ways to overcome this but limited real action occurred over the course of the study. This is understandable

considering the studies short duration and even though direct action did not occur, some students did move past an internalised perception of inequity. This resulted in them challenging the thinking of others and beginning to suggest external solutions to inequity (See section 4.44). Students also developed the confidence to express their feelings about racism and sexism in New Zealand society with teachers and their own families and there was a growing awareness from students that they did not have to accept the way things were (See section 4.45). One teacher described this as “developing a sense of entitlement in a positive way”.

Reflection by teachers at times, did lead to pedagogical actions that had the potential to move student’s past enlightenment (becoming aware) towards empowerment (becoming critical) through to emancipation (taking action). The findings in the current study align with those of Baron (2015). She illustrated that through reflection, teachers develop an awareness that they need to understand, explore and articulate their own beliefs and practices in order to challenge the validity of them. Teachers in the current research found that rather than detracting from the mathematics that TMfSJ had actually made the mathematics more accessible to the students. This resulted in deeper conceptual learning. Furthermore, rather than the negative statistics disempowering students as teachers thought they would they had led to an emerging critical consciousness that if developed further could lead to the possibility of emancipation.

Teacher actions had supported the students to engage in debates, which included the notion of racism and inequity. However, through reflection teachers realised they had not gone far enough, and they had missed opportunities to take the social justice learning further. Instead of discussions about racism and inequity, occurring at surface level teachers realised that they needed to dig deeper into discussions about institutionalised racism and systemic structural inequity.

Freire (2000) asserts that education that liberates the individual must be a conscious act in which the content is understood and analysed. The role of the teacher therefore is to problematize the world that surrounds the oppressed and create the appropriate conditions to move learning beyond belief or opinion towards rationality and reason. Throughout the study, many of the students believed racism played a part in the negative statistics experienced by Māori and Pāsifika. However, by the end of the study one student was able to use rationality and reason to link that inequity and racism to colonialism (See section 4.45). Freire argues that it is through this reflective state that students discover their own reality. They are then able to create new expectations and move toward a self-construction of the world in which they have real and direct participation in the activities they undertake.

As the teachers understanding of TMfSJ changed, they used pedagogical actions to push students past their beliefs and opinions. When students examining life expectancy internalised the statistics and blamed themselves the teacher got them to reflect on external reasons and the students began to look at the data compared to other indicators of inequity and realise how they were inter-related. The students were then able to see the statistics as not a reflection on Māori and Pāsifika but as a reflection of inequity in wider society. This realisation opened up the possibility of praxis occurring. The teachers by questioning their own beliefs and practices realised that they could teach through a Social Justice lens and have students read and write the world with mathematics as well as meet and at times exceed the mathematical goals set out in the curriculum.

The study would need to be considerably longer to move students past the surface level shifts that occurred. However, the potential mathematics education has to contribute to liberatory social change was shown. By implementing a problem posing pedagogy teachers and students were both challenged to reconsider and recreate their prior

knowledge and question their beliefs. This led to the development of new understandings based on rationality and reason and the discarding of deficit thinking opening up the potential for what Freire (2000) describes as emancipation to take place.

5.4 Summary

The findings identified that teachers went into the study with narrow views of what TMfSJ involved. They initially also believed that the main challenges they would face when TMfSJ would involve maintaining the rigor of the mathematics as well as meeting the perceived expectations of Senior Leadership and students' whanau. What was not anticipated was the degree that the students' internalised oppression would present as a barrier to them seeing the data as a reflection of societal malaise not as a reflection of any internal or cultural inadequacy. Although internalised oppression presented as the biggest challenge to TMfSJ the exposure of it afforded the teachers the opportunity to confront the deficit thinking of their students and in turn confront their own beliefs about teaching mathematics.

Through reflection, the teachers' beliefs about TMfSJ shifted and the Talanoa moved towards providing opportunities for students to examine critically societal issues, connect these to their own experiences and seek solutions to transform inequity. Like previous research (Baron, 2015; Bartell, 2006; Planas & Civil 2009) the findings illustrated that teacher empowerment through reflection was related to the empowerment of their students and presented the possibility of liberation for both

5.5 Implications for Education

Māori and Pāsifika as a group are over-represented in every single indicator of inequity in New Zealand. This includes incarceration rates, suicide, drug addiction, to homelessness and poverty. This is unsurprising considering that Māori and Pāsifika youth

are over-represented when it comes to educational underachievement in core curriculum areas including mathematics. The reasons for this have been documented by various researchers (e.g., Anae et al., 2001; Barton, 1995; Bills & Hunter 2015; Hunter & Anthony, 2011; Hunter, Hunter, Anthony & McChesney, 2018) and include a disconnect between the Eurocentric habitus of school and the lived reality of students, as well as systemic factors. What the current study suggests which supports earlier research by Hunter and Hunter (2017) is that internalised oppression and subsequent deficit thinking by students is a factor as well.

Conventional wisdom would suggest that if internalised oppression were a factor in underachievement then presenting examples of inequity would exacerbate this. However, what the current study has shown is that by making oppression and its causes, objects of reflection (Freire, 2000) the opportunity for liberation becomes possible.

The study has shown that meeting Gutstein's (2006) social justice and mathematical pedagogical goals is therefore possible in a New Zealand classroom. The teachers by providing opportunities to examine critically issues of inequity resulted in the students' being able to understand or read the world with mathematics. They also provided the opportunity for students to change or write the world, develop positive cultural and social identities, succeed academically in the traditional sense and change their orientation to mathematics (Gutstein, 2006). Furthermore, the study has shown that these goals are compatible with the Ministry criteria that students *explore relationships in quantities, space, and data and learn to express these relationships in ways that help them make sense of the world around them* (Ministry of Education, 2007, p. 17).

The results of this current study confirm the importance of an ongoing process of reflection and narrative (Talanoa) by teachers to support students to engage in the

development of a critical consciousness. Teachers need to challenge their own beliefs about teaching mathematics. This is because TMfSJ requires more than exploring critical social issues or challenging injustices through mathematics. The teacher actions and classroom culture that encourages opportunities for equal participation is equally important as it develops student agency which leads to empowerment and liberation becoming possible.

The findings of this study suggest teachers can teach mathematics for social justice and still maintain the rigor of mathematics. This contradicts such researchers as Becker and Jacob (2000), Harel (2010) and Heid (2010) who suggest otherwise. However, the question remains, is there the political will to have them teach mathematics for social justice so that students are given the opportunity to truly *make sense of the world around them* (Ministry of Education, 2007, p. 17).

5.6 Opportunities for further research

The following issues identified from the results and implications of the study warrant further research.

1. Apart from problem two (see Appendix F) which had a focus on percentages the study utilised the statistics strand of mathematics. Most often statistics is used for TMfSJ, to show inequity. What problem two showed was the possibility of TMfSJ in other areas of mathematics. It would be timely to explore TMfSJ research into other areas of the mathematics curriculum.
2. Students in this study were from a low decile school and were predominantly Māori and Pāsifika. Further research would be appropriate to compare how students from other cultural groups and in schools with

higher decile levels respond to the same data and whether this can make them critically conscious of their own privilege.

3. A related area to consider for research is the role student collaboration within dialogical pedagogy played in the development of a critical consciousness. Freire (2000) asserts that the essence of dialogue is critical thinking and that dialogue leads to empowerment. The impact peers made in shifting thinking from internal factors to considering other influences was touched on in the study, but further investigation is warranted into the classroom environment that best supports this discourse to occur.
4. Nolan (2009) asserts that what is missing from most mathematics for social justice teaching is a critical stance on the mathematics itself. In the current study, mathematics was used as a tool for examining social justice issues, but the role mathematics plays, as a tool of colonialism was not addressed. Mathematics was used for social critique but was not the subject of critique (Skovsmose, 1994). This issue warrants further research as to what counts as mathematics and whose purpose that serves.

5.7 Concluding thoughts

This research adds to an aggregation of knowledge about the teaching of mathematics for Social Justice. The design of the study was modelled on the multi-layered critical discussions and free conversations provided by Talanoa (Vaiolleti, 2006). As this case study was concerned with the potential empowerment of teachers and students and challenging structural inequities the research design needed to engage the participants in critical dialogue, decision-making and strategic action. This was necessary as the research had emancipatory intent. The flexibility offered by Talanoa, allowed this

to occur as well as providing opportunities to probe, challenge, clarify and re-align the narrative.

This study examined the challenges teachers face when teaching mathematics for social justice. The purpose was to ascertain whether teachers could maintain mathematical rigor as well as re-imagining mathematics education as a means to create a more socially just world. The evidence from this research would suggest that this is possible. As the teachers became more knowledgeable, their power increased and this in turn empowered students through reciprocal and reflexive practice.

Freire's (2000) concept of praxis reinforces that if injustice and inequity are to be transformed it will require more than coming to understand them through reflection. Direct action will be required. The New Zealand Curriculum statement that mathematics should *help students make sense of the world around them* is important therefore as political consciousness is cultivated through a critical understanding of reality. If students can use mathematics to critically understand the world in which they live, they are better equipped to change that world.

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Appendix A: Teacher information sheet



Teacher information sheet

My name is Trevor Bills and I am a senior member of the Developing Mathematical Inquiry Communities (DMIC) team. I am currently doing research focusing on examining the challenges teachers may face when introducing Social Justice problems into their mathematics programme. I am also interested in exploring how these challenges are managed within the classroom context as students engage in using a range of mathematical practices to explain and justify their reasoning. I am writing to invite you to participate in this collaborative research in Term 4, 2019. This will involve the Year 7-8 teachers in professional development directly linked to your own classroom.

The professional development programme will involve you as co-researcher trialling activities, and evaluating your teaching in relation to mathematical learning and social justice. To facilitate this inquiry you will be involved in interviews and reflective practices such as classroom observations (with audio/video records). I will also interview case study students. Permission with regard to audio/video recording will be sought from both parents and children in your class. The focus of the study is on the teaching strategies, and thus it will be possible to organize the recording devices to avoid those students who do not consent to participate.

The project includes professional development meetings within a professional learning group comprised of the researcher and teachers from the schools. The time involved in

the professional development meetings for you will be no more than 6 hours. The time involved for your interviews will be no more than 2 hours.

During this research, no more than five mathematics lessons will be video-recorded and work samples from each lesson will be collected and photo-copied. The observations will take place in the classroom and be part of the normal mathematics programme.

The time involved in the complete study for you will be no more than 10 hours over a period of a school term. All project data collected during individual interviews and filming will be stored in a secure location, with no public access and used only for this research and any publication arising from this research. After completion of five years, all data pertaining to this study will be destroyed in a secure manner. All efforts will be taken to maximise confidentiality and anonymity for participants. Names of all participants and the school will not be used once information has been gathered and only pseudonyms and non-identifying information will be used in reporting.

Please note that you are under no obligation to accept this invitation. If you decide to participate you have the right to:

- Decline to answer any particular question;
- Withdraw from the study after four weeks;
- Ask any questions about the study at any time during participation;
- Provide any information on the understanding that your name will not be used unless you give permission to the researcher;
- To ask for the audio or video-recorder to be turned off at any time during the interviews and any comments you have made be deleted;
- Be given access to a summary of the project findings when it is concluded.

If you have any further questions about this project you are welcome to discuss them with me personally:

Trevor Bills. Phone: 021101793. Email: t.d.bills@massey.ac.nz

Or contact either of my supervisors at Massey University

- Professor Roberta Hunter (09) 414 0800 ext.43530. Email. R.Hunter@massey.ac.nz

Institute of Education, Private Bag 102 904, North Shore, Auckland 0745

- Jodie Hunter ((09) 414 0800 ext.43518. Email. J.Hunter1@massey.ac.nz

Institute of Education, Private Bag 102 904, North Shore, Auckland 0745

Appendix B: Problem One

Teaching focus:

Compare explanations and develop the norm of what makes an acceptable explanation.
Reinforce what makes it mathematical

Ask the students to provide mathematical reasons for agreeing or disagreeing with an explanation. Vary when this is required so that the students consider situations when the answer is either right or wrong.

Big Idea: Mathematics from curriculum Key Ideas

L4: Comparison and relationship investigative questions will be posed and explored. Comparison investigative questions need to be about the group of interest and have an aggregate focus. Is there a relationship between ethnicity and gender and pay? Students should be writing statistically sound statements about what their displays show. The starter “I notice...” is a useful way to encourage students to write about what their displays show. In addition students should be encouraged to write “I wonder...” statements for further investigation.

Curriculum Elaborations:

S4-1: Plan and conduct investigations using the statistical enquiry cycle:

- determining appropriate variables and data collection methods
- gathering, sorting, and displaying multivariate category, measurement, and time-series data to detect patterns, variations, relationships, and trends
- comparing distributions visually
- communicating findings, using appropriate displays.

Specific Learning Outcome:

Students will be able to:

- discuss differences and similarities between distributions, clusters and outliers within distributions, associations of variables, trend over time

Mathematics Goal from Essence Statement:

The New Zealand Curriculum, Ministry of Education, (2007), pg17 states; “In mathematics, students explore relationships in quantities, space, and data and learn to express these relationships in ways that help them *make sense of the world around them*”.

Social Justice Goals from Social Science Curriculum Essence Statement:

Students will be able to:

- Engage critically with societal issues
- Develop an understanding of their role in the economy and of how economic decisions affect individual and communities
- Examine relevant current issues
- Reflect on and evaluate the understandings they have developed and the responses that may be required

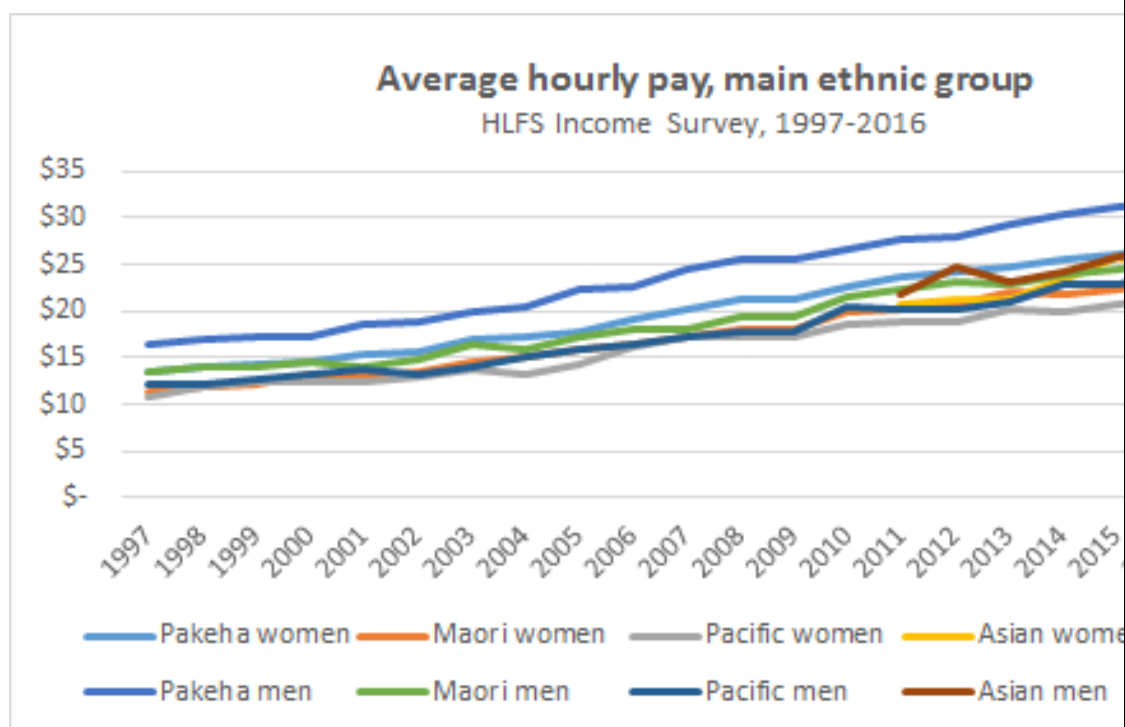
AO from curriculum: L4:

- Understand how formal and informal groups make decisions that impact on communities.

AO from curriculum: L5:

- Understand how economic decisions impact on people, communities, and nations
- Understand how people define and seek human rights

Problem: Looking at this graph, what information does it tell us? What statements can we make about average hourly wages in New Zealand?



Conjectures: Possible strategies/solutions/misconceptions (which the students may use)

Additional strategies/solutions/misconceptions (which emerged during lesson).

Students will notice different ethnicities earn different amounts. Students will recognise gender impacts on amount earned Students will recognise that even allowing for gender Pakeha earn more Students will begin to work out differences in terms of dollars earned e.g. in 1997 Pakeha men earned approx. \$16 and Pasifika women earned \$11 a \$5 difference Students will realise that this disparity has increased over the time period shown e.g. In 2016 Pakeha men earned approx. \$32 and Pasifika women earned approx. \$17 a \$15 difference Students might ask about Asian hourly rates and why they not reported until 2011. First CHCH earthquake was 2010 influx of Asian workers for rebuild. Once students have made maths statements, they may start to talk about the unfairness of the data or racism.	
Generalising- how will I connect strategies to big idea: (further examples to extend student's understanding): As students read statements and justify record them on board. Challenge students to use correct mathematical language and to use the labels on the graph. Talk about the x and y axis. What is the graph showing us. Once all statements up ask students to group common statements together. E.g. statements about one set of data (summative) e.g. Pakeha earn the most. OR statements about two or more sets of data e.g. Pakeha earn more than Pasifika, Comparative uses bi variant data OR Statements that look at data over time, relational statements e.g. the gap between Pakeha men and Pasifika women is widening over time or it has increased by three times. Uses multi variant data. Challenge students to predict what gap will be in 10 years time. Challenge students to make statements about fairness if these have not come up, is the data a reflection on NZ society. Is it fair?	

Formative assessment:
Reflection: where to next with student learning/pedagogical actions

Appendix C: Teacher Questionnaire



What is your understanding of Social Justice in education? What do you think it would like?

Can the pedagogical choices teachers make be acts of social justice? How?

Have you used a maths question that looked at Social justice before? If yes, can you recall what it was and why you chose it? If no, why not?

What do you think Social Justice within mathematics looks like

What pedagogical approaches could be used to support a social justice approach to mathematics?

What are the social justice issues evident within the schools local geographic community?

What social justice issues are evident in the cultural and socio-economic backgrounds of your students?

Does social justice have a place within mathematics? Why? Why not?

What challenges do you think TMFSJ will present?

Appendix D: Teacher Question Starters

Thesis questions Teachers:

1. How do you think the lesson went?
2. Did anything surprise you?
3. Were the maths AOs achieved?
4. What about the social justice aims, did anything come out there?
5. How do you see this fitting into the maths curriculum? Does it have a place?
6. Prior to today, had you taught a problem that looked at Social Justice Issues.
7. What challenges did today's lesson present in terms of TMFSJ
8. Should teachers be involved with exposing issues of Social Justice?
9. Should teachers share their own feelings about social justice?
10. Can mathematics and should mathematics be seen as political? How?

Appendix E: Questions Students

1. What was today's lesson about? What did you learn about?
2. Did you enjoy today's lesson? Why? Why not?
3. What maths did you learn from it?
4. What else did you learn from today's lesson?
5. Is NZ a fair country? If yes, why? what makes it fair? If no, why? what makes it unfair?
6. Culture and maths?

Appendix F: Problem 2

Teaching focus: **Developing generalisations: Representing a mathematical relationship in more general terms. Looking for rules and relationships. Connecting, extending, reconciling.**

Ask the students to consider if the rule or solution strategy they have used will work for other numbers. Consider if they can use the same process for a more general case. (e.g. what happens if you multiply any number by 2)

Or in this case how can knowing how to work out 10% help us to work out 20, 30, 45% etc

Big Idea: Maths Curriculum elaboration

L4

NA4-3: Find fractions, decimals, and percentages of amounts expressed as whole numbers, simple fractions, and decimals.

- **A percent is another way to write a decimal that compares part to a whole where the whole is 100 and thus can be associated with the corresponding point on the number line.**
- **Percent is relative to the size of the whole.**

Social Justice Goals from Social Science Curriculum Essence Statement:

Students will be able to:

- Engage critically with societal issues
- Develop an understanding of their role in the economy and of how economic decisions affect individual and communities
- Examine relevant current issues
- Reflect on and evaluate the understandings they have developed and the responses that

may be required

Problem:

Minimum Wage vs Living Wage

The minimum wage in New Zealand is \$17.70 per hour or \$708.00 per week before tax.

The tax rate is 17.5%. How much money does someone on the minimum wage receive after tax is deducted? Is this enough money to live on and support a family?

The living wage in New Zealand is \$21.15 per hour or \$846 per week before tax.

The tax rate is 17.5%. How much money does someone on the living wage receive after tax is deducted? How much more is this than for the minimum wage? Is this enough money to live on and support a family?

Average Rental Mangere 3 bedroom house: \$487.00

Average weekly Supermarket spend for family of 5: \$290.00

Conjectures: Possible strategies/solutions/misconceptions (which the students may use) Mathematically: students work out 10% then halve for 5% then halve for 2.5% Students workout 10%, 5% then 1% Students work out 10% and get stuck after that Students attempt to apply a rule Students distribute the % but do not add at end Social Justice aims: The minimum wage is not enough to live on and that is why a living wage is necessary. It is not fair that someone needs to work 2 jobs to survive The cost of living in Auckland is leading to hardship for a lot of people People end up living in cars despite working full time as pay not enough Discussion around parents both working 2 or more jobs as minimum wage not enough Living wage also not enough Unfair that you work hard and still do not have enough to live	Additional strategies/solutions/misconceptions (which emerged during lesson). Students worked out 10% then divided by 4 and multiplied by three to work out 7.5 % Social Justice: Students discussed how their parents often work long hours at 2 jobs and are not there at night not in morning Parents do not have as much family time as they are always working

Generalising- how will I connect strategies to big idea: (further examples to extend student's understanding):

NA4-3: Find fractions, decimals, and percentages of amounts expressed as whole numbers, simple fractions, and decimals.

Ask the students to consider if the rule or solution strategy they have used will work for other numbers. Consider if they can use the same process for a more general case. (e.g. what happens if you multiply any number by 2)

Or in this case how can knowing how to work out 10% help us to work out 20, 30, 45% etc

Appendix G: Problem 3

Teaching focus: Compare explanations and develop the norm of what makes an acceptable explanation. Reinforce what makes it mathematical

Ask the students to provide mathematical reasons for agreeing or disagreeing with an explanation. Vary when this is required so that the students consider situations when the answer is either right or wrong.

Big Idea: Mathematics from curriculum Key Ideas

L4: Comparison and relationship investigative questions will be posed and explored. Comparison investigative questions need to be about the group of interest and have an aggregate focus. Is there a relationship between ethnicity and gender and pay? Students should be writing statistically sound statements about what their displays show. The starter “I notice...” is a useful way to encourage students to write about what their displays show. In addition students should be encouraged to write “I wonder...” statements for further investigation.

E.g. I wonder why as a % of population there are differences in unemployment based on ethnicity?

The variables of interest are clear and available

The Population of interest is clear

The intent of the question is clear

The question is worth investigating and is interesting

The question allows for analysis of the whole group

The question can be answered with the data / with data

Curriculum Elaborations:

S4-1: Plan and conduct investigations using the statistical enquiry cycle:

- determining appropriate variables and data collection methods
- gathering, sorting, and displaying multivariate category, measurement, and time-series data to detect patterns, variations, relationships, and trends
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Social Justice Goals from Social Science Curriculum Essence Statement:

Students will be able to:

- Engage critically with societal issues
- Develop an understanding of their role in the economy and of how economic decisions affect individual and communities
- Examine relevant current issues
- Reflect on and evaluate the understandings they have developed and the responses that may be required

AO from curriculum: L4:

- Understand how formal and informal groups make decisions that impact on communities.

AO from curriculum: L5:

- Understand how economic decisions impact on people, communities, and nations
- Understand how people define and seek human rights

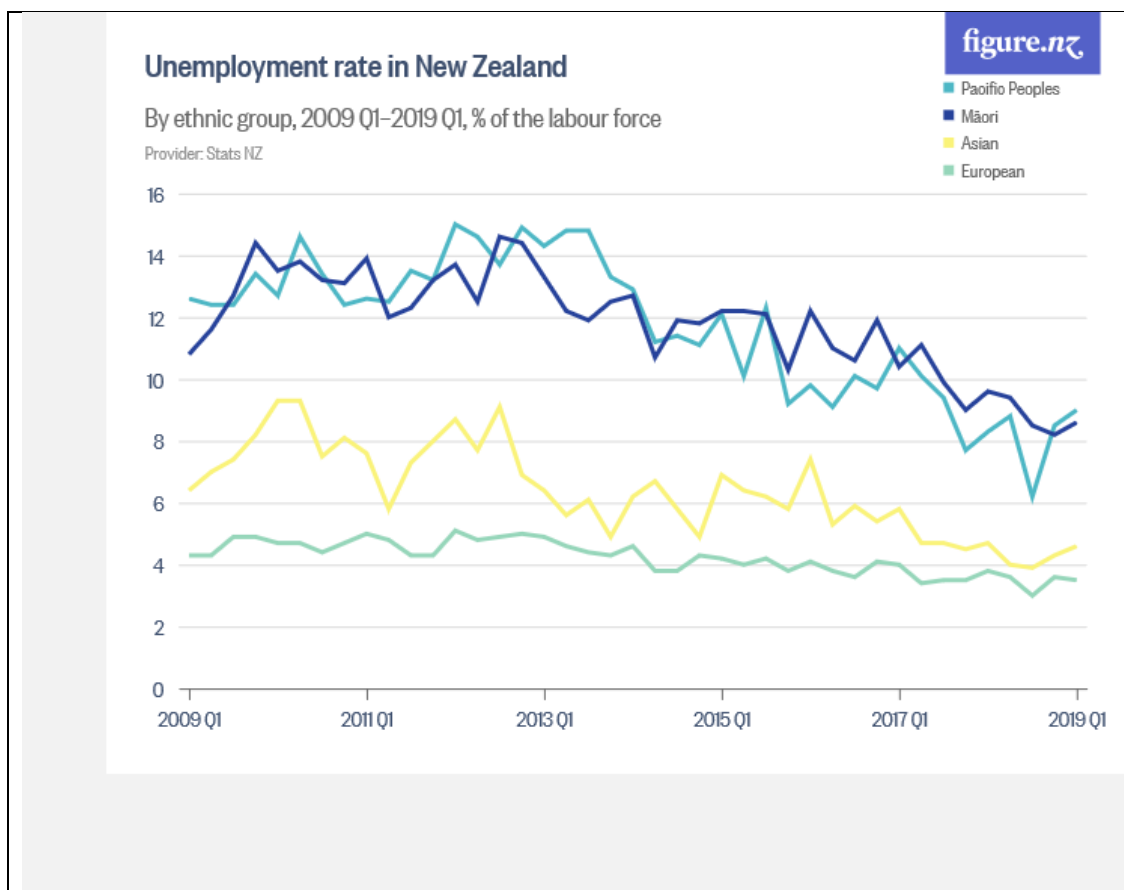
Problem: Looking at the graph, what information does it tell us?

What statements can we make about unemployment in New Zealand?

What statements can we make about New Zealand Society?

Use “I notice...” and “I wonder...” statements for further investigation.

What actions could you make to change things?



Conjectures: Possible strategies/solutions/misconceptions (which the students may use)

Students will notice different ethnicities have different levels of unemployment
 Students will recognise that Europeans have the lowest level of unemployment and Asians the second lowest
 Students will recognise that Māori and Pāšifika have the highest rates of unemployment
 Students will recognise that European unemployment rate is relatively stable around 4% and other ethnicities fluctuate more over the years

Students will begin to work out differences in of % e.g. that Māori and Pāšifika unemployment was 7% to 9% more than European in 2009

Additional strategies/solutions/misconceptions (which emerged during lesson).

Students may be able to link drops in unemployment to significant events in NZ such as the Christchurch earthquakes where a lot of people moved to CHCH for the rebuild

Students may recognise the drop in unemployment from 2017 for Māori and Pāsifika and attribute it to what occurred politically at this time

Students may attribute the differences in unemployment levels to external factors such as racism

Students may attribute the differences in unemployment levels to internal factors such as Europeans working harder / being more qualified and the high rates of Māori and Pāsifika unemployment to them being lazy as internalised oppression was a common theme across the first two problems.

They may link this graph to the first graph on average wages.

Students may discuss the unfairness of the data and think about ways to change it, this will probably be internalised e.g. Māori and Pāsifika need to work harder at school to get a better job.

Generalising- how will I connect strategies to big idea: (further examples to extend student's understanding):

As students read statements and justify record them on board. Challenge students to use correct mathematical language and to use the labels on the graph. Talk about the x and y axis. What is the graph showing us.

Once all statement up ask students to group common statements together. E.g. statements about one set of data (summative) OR statements about two or more sets of data e.g.

Comparative uses bi variant data OR Statements that look at data over time, relational statements

Challenge students to predict what the data will be in 10 years' time.

Challenge students to make statements about fairness if these have not come up, is the data a reflection on NZ society. Is it fair?

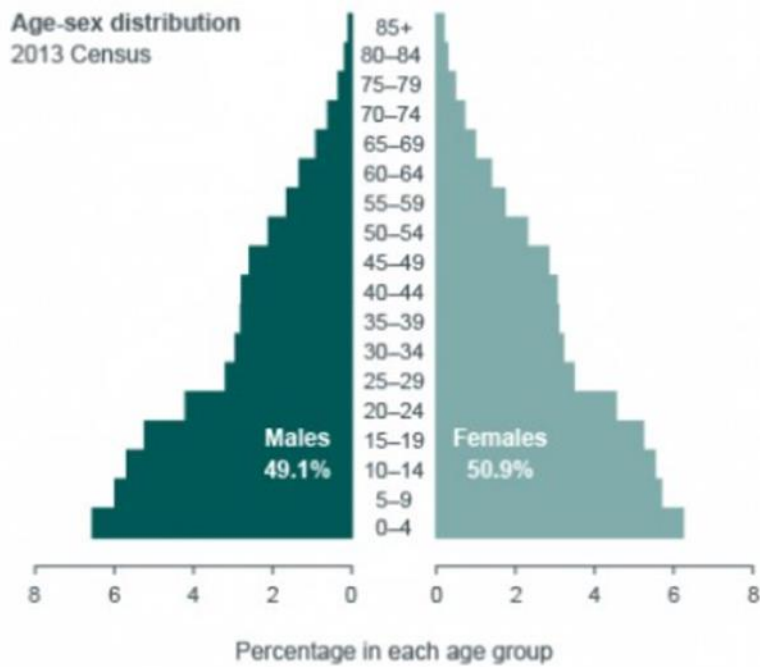
Challenge students to come up with ways that they can change the data.

Formative assessment:

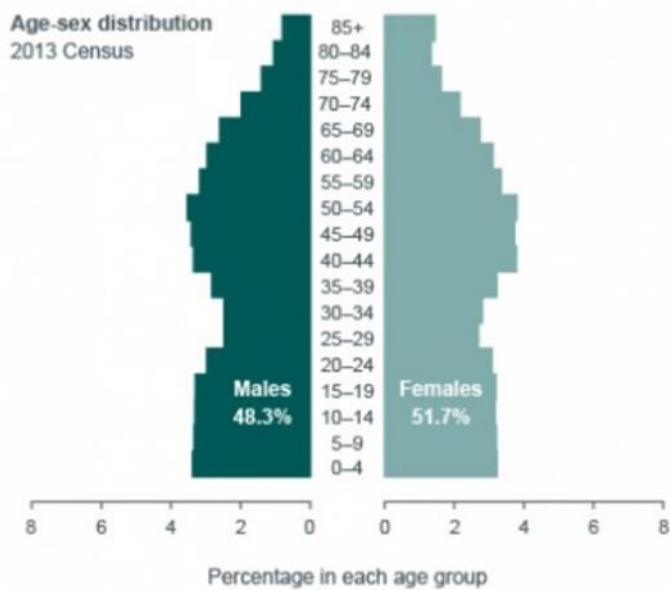
Reflection: where to next with student learning/pedagogical actions

Appendix H: Problem 4

Pacific peoples



European

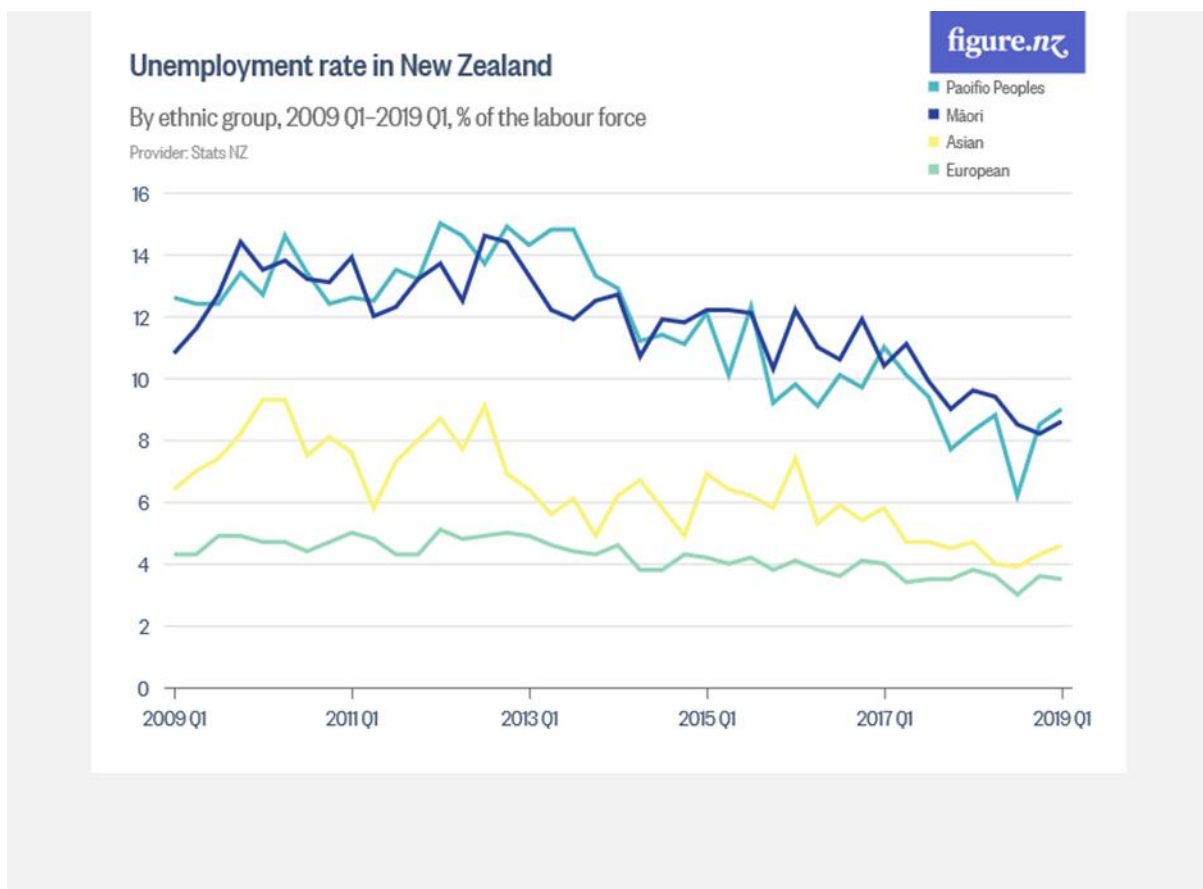


Compare the two graphs above. What statements can you make about the age distribution of Europeans and Pacific people living in Aotearoa New Zealand?

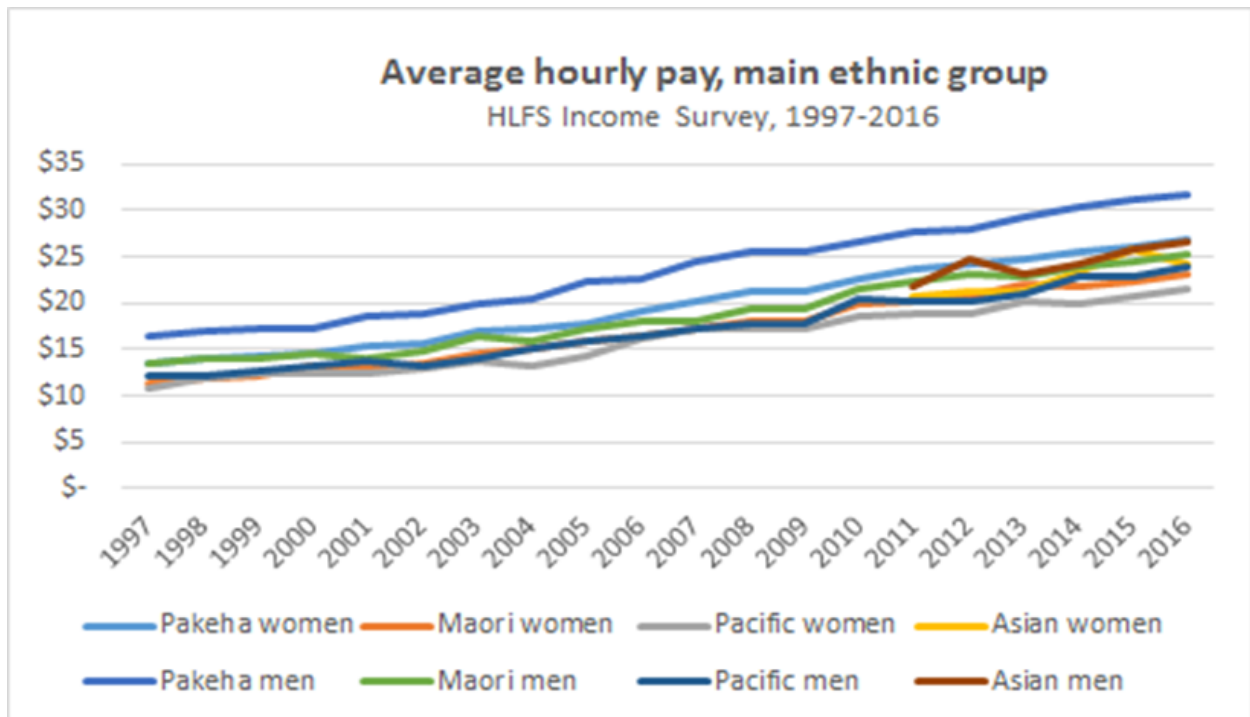
Think about life expectancy

Compare these two graphs with the graph on unemployment?

What statement can you make about unemployment in NZ in the future?



Appendix I: Problem 5



In 1997 Pasific women earnt on average \$11.00 an hour compared to Pakeha men who earnt \$17.00 an hour.

In 2016 Pasific women earnt on average \$17.00 an hour compared to Pakeha men who earnt \$32.00 an hour.

What is the percentage increase for each group over this time period.

What statements can you make about this? Use I notiice and I wonder.

Appendix J: Student Consent Form



CONSENT FORM: STUDENT PARTICIPANTS

THIS CONSENT FORM WILL BE HELD FOR A PERIOD OF FIVE (5) YEARS

I have read the Information Sheet and have had the details of the study explained to me.

My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I agree/do not agree to be audio taped during mathematical lessons.

I agree/do not agree to be video taped during mathematical lessons.

I agree/do not agree to be interviewed and audio taped after the mathematics lesson

I agree to participate in this study under the conditions set out in the Information Sheet.

Signature: Date:

Full Name - printed

Appendix K: Ethics



Project Title

1. Developing mathematical resilience among diverse learners
2. Challenges in teaching mathematics for social justice

Summary

The aim of this research is to investigate how students learn resilience when teachers explicitly notice and respond to student use of a range of mathematical practices. As part of this research we will explore different aspects of inquiry mathematics within ambitious settings as students engage with complex tasks which may cause confusion and a sense of being stuck. Space will be given to explore how students react to explaining and justifying their reasoning, being questioned, being challenged, or being disagreed with. Likewise, teachers will be given space to explore how they have noticed and responded to their students' engagement in mathematical practices as they encounter discursive situations.

At the same time the challenges teachers face when teaching mathematics for social justice will be examined as well as the ways these challenges may be overcome.

Data gathering will include video recorded observations of two sets of five lessons with a focus on the small group independent activity and the post independent activity teacher-led discussion. Before the beginning of the study, interviews will be undertaken with students to explore their perceptions of how they respond to challenging situations.

Teacher interviews will be conducted post lessons to explore their perceptions of their actions in response to mathematical practices and other aspects of the students' behaviour in relationship to challenging situations. Ipad interviews will be conducted post lessons with students responding to questions which explore different aspects of resilience.

Data will be wholly transcribed and analysed. It will be held in a secure space for five years and then deleted. Anonymity will be maintained at all times, and all data will only be accessed by the researchers and a transcriber who will sign a confidentiality agreement.

Project Start/End Date: 23/07/2019 to 23/07/2020

Peer review process:

1. Peer-reviewed by team members: The ethical issues involved in this project have been discussed in detail with Prof. Roberta Hunter, Dr. Jodie Hunter, Dr. Rachel Restani and John Moala from the Institute of Education at Massey University. We are all co-researchers in this project.
2. The principal at the school site will be contacted with information about the project. We are communicating with them about the best ways to conduct research to ensure the comfort and safety of the students and teachers.

Standard protocols will be put in place.

List the ethical issues considered and explain how each has been addressed

The teachers' involvement in this research will be no more than that which occurs in normal DMIC mathematics lessons, and regular reflection on their lessons with the DMIC mentors. We will only interview teachers who give consent.

The only interaction we (researchers) will have with students will be during the student interviews. All students and caregivers will be given information sheets with details about the project. We will give students consent forms to inform them of the purpose of the interviews, how the interviews will be conducted and how the data will be stored. The video-taping of the classroom lessons will be focused on the teacher and students, which is regular DMIC practice. We will only interview and video record students who give consent along with consent from their caregivers.

We will only use data gathered from video recordings of students and teachers who give consent. Video recordings will only be for researchers to view and will not be shared publicly. In order to maintain anonymity, the schools, students, and teachers will be assigned pseudonyms in any publications arising from this research. We will not share students' direct quotes with their teachers.

All data (electronic audio and video files) will be stored in a secured location with no public access and used only for this research. Students and teachers will be informed that they have the right to: decline to participate; decline to answer any particular question in the interview; ask to have the audio or video tape turned off at any time; withdraw from the study at any point; ask questions about the study; and be given access to a summary of the project findings when it is concluded. It is unlikely that the research results will bring about harm to the community.

With whom did you peer review your research?

Prof. Roberta Hunter

Dr. Jodie Hunter

Dr. Rachel Restani

Dr. John Moala

Don Biltcliff

Trevor Bills

If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher(s), please contact Professor Craig Johnson, Director (Research Ethics), email humanethics@massey.ac.nz.

Appendix L: Student Information Sheet



STUDENT INFORMATION SHEET

My name is Trevor Bills. I work at Massey University. I am doing some research focusing on understanding how your teacher supports you to communicate and participate in mathematics in your classroom. Your teacher is one of a group of teachers in this school taking part in this research study this term.

As part of the research we will need to make some classroom observations and therefore I am writing to ask your permission for you to be audio or video recorded as part of your teacher's record of their practice. The focus of the recordings will be on your teachers' teaching strategies and so at no time will you be focused on or audio or video recorded for any length of time. The recordings would be of usual mathematics lessons and so you would not need to do anything special for the cameras or tape-recorder. In addition, we may want to talk to you about the mathematics lesson for a short time after the lesson.

All data recordings will be stored in a secure location, with no public access and used only for this research. In order to maintain anonymity the school name and name of all participants will be assigned pseudonyms in any publications arising from this research. At the end of the year, a summary of the study will be provided to the school and made available for you to read.

Please note you have the following rights in response to my request for you to participate in this study.

- decline to participate;
- decline to answer any particular question;
- withdraw from the study at any point;
- ask any questions about the study at any time during participation;
- provide information on the understanding that your name will not be used unless you give permission to the researcher;
- be given access to a summary of the project findings when it is concluded;
- have the right to ask for the audio/video tape to be turned off at any time during the observations;

If you have any further questions about this project you are welcome to discuss them with me personally:

Trevor Bills. Phone: 021101793. Email: t.d.bills@massey.ac.nz

Alternatively, contact of my supervisors at Massey University

- Professor Roberta Hunter (09) 414 0800 ext.43530. Email. R.Hunter@massey.ac.nz

Institute of Education, Private Bag 102 904, North Shore, Auckland 0745

- Dr Jodie Hunter ((09) 414 0800 ext.43518. Email. J.Hunter1@massey.ac.nz

Institute of Education, Private Bag 102 904, North Shore, Auckland 0745

This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named above are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher(s), please contact Professor Craig Johnson, Director (Research Ethics), email humanethics@massey.ac.nz.

Appendix M: Teacher Information Sheet and Consent form



Teacher information sheet

My name is Trevor Bills and I am a senior member of the Developing Mathematical Inquiry Communities (DMIC) team. I am currently doing research focusing on examining the challenges teachers may face when introducing Social Justice problems into their mathematics programme. I am also interested in exploring how these challenges are managed within the classroom context as students engage in using a range of mathematical practices to explain and justify their reasoning. I am writing to invite you to participate in this collaborative research in Term 4, 2019. This will involve the Year 7-8 teachers in professional development directly linked to your own classroom.

The professional development programme will involve you as co-researcher trialling activities, and evaluating your teaching in relation to mathematical learning and social justice. To facilitate this inquiry you will be involved in interviews and reflective practices such as classroom observations (with audio/video records). I will also interview case study students. Permission with regard to audio/video recording will be sought from both parents and children in your class. The focus of the study is on the teaching strategies, and thus it will be possible to organize the recording devices to avoid those students who do not consent to participate.

The project includes professional development meetings within a professional learning group comprised of the researcher and teachers from the schools. The time involved in

the professional development meetings for you will be no more than 6 hours. The time involved for your interviews will be no more than 2 hours.

During this research, no more than five mathematics lessons will be video-recorded and work samples from each lesson will be collected and photo-copied. The observations will take place in the classroom and be part of the normal mathematics programme.

The time involved in the complete study for you will be no more than 10 hours over a period of a school term. All project data collected during individual interviews and filming will be stored in a secure location, with no public access and used only for this research and any publication arising from this research. After completion of five years, all data pertaining to this study will be destroyed in a secure manner. All efforts will be taken to maximise confidentiality and anonymity for participants. Names of all participants and the school will not be used once information has been gathered and only pseudonyms and non-identifying information will be used in reporting.

Please note that you are under no obligation to accept this invitation. If you decide to participate you have the right to:

- Decline to answer any particular question;
- Withdraw from the study after four weeks;
- Ask any questions about the study at any time during participation;
- Provide any information on the understanding that your name will not be used unless you give permission to the researcher;
- To ask for the audio or video-recorder to be turned off at any time during the interviews and any comments you have made be deleted;

- Be given access to a summary of the project findings when it is concluded.

If you have any further questions about this project you are welcome to discuss them with me personally:

Trevor Bills. Phone: 021101793. Email: t.d.bills@massey.ac.nz

Or contact either of my supervisors at Massey University

- Dr Roberta Hunter (09) 414 0800 ext.43530. Email. R.Hunter@massey.ac.nz

Institute of Education, Private Bag 102 904, North Shore, Auckland 0745

- Jodie Hunter ((09) 414 0800 ext.43518. Email. J.Hunter1@massey.ac.nz

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If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher(s), please contact Professor Craig Johnson, Director, Research Ethics, telephone (06) 350 5249, email humanethics@massey.ac.nz

CONSENT FORM: TEACHER PARTICIPANT

THIS CONSENT FORM WILL BE HELD FOR A PERIOD OF FIVE (5) YEARS

I have read the Information Sheet and have had the details of the study explained to me.
My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I agree/do not agree to the interview being sound recorded.

I agree/do not agree to the interview being image recorded.

I agree to participate in this study under the conditions set out in the Information Sheet.

Signature:

Date:

.....

Full Name - printed

.....