Pāsifika Students' Perspectives and Understandings of Mathematics Embedded Within Their Lives Beyond the Classroom

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Research in both the New Zealand and international contexts identifies the need for New Zealand classrooms to foster culturally responsive and mathematical practices that align with Påsifika students' cultural values, backgrounds, interests and experiences. The aim of this study was to investigate how the use of culturally responsive tasks along with cultural practices can foster Påsifika students' participation and engagement in mathematics. Eleven Year 5 and 6 students used cameras to document their out-of-school mathematical experiences. These photographs were used to design culturally relevant tasks that were implemented in the classroom. In this paper, we analyse the students' perspectives and understandings of mathematics embedded within their lives beyond the classroom.

Introduction

Both in New Zealand and internationally, the engagement and achievement of diverse students in mathematics is a continuing focus for research and policy. The population of Påsifika students in New Zealand schools continues to grow and these students come to schooling with a wide variety of experiences and knowledge originating from their cultural heritage and background. However, frequently learning experiences they encounter in New Zealand schools is segregated from their home life and cultural experiences. Research studies (e.g., Averill, 2012; Hunter & Hunter, 2018; Hunter & Hunter, in press) suggest that many schools in New Zealand provide Eurocentric tasks and practices in mathematics classrooms that make it difficult for Påsifika learners to make connections to their life experiences and mathematics outside of school. This paper investigates Påsifika students' perspectives of mathematics at home and school and their understanding of the mathematics that is embedded within their life experiences that they engage in outside of school. It examines how students' out-of-school mathematical experiences can be integrated into the classroom to strengthen links between home, school and community mathematics.

Research Literature

Engagement in mathematics is the extent to which students develop a positive connection to mathematics, seeing it as purposeful and valuable (Cobb & Hodge, 2007). Engagement is enhanced when students develop a positive mathematical disposition. This disposition is formed when students value mathematics, make connections between the mathematics they learn in and out of school, and discover the relevance and importance of mathematics to their current and future lives (Boaler, 2002; Matthews, 2017; Wright, 2017). With traditional teaching approaches still prominent in classrooms, students struggle to identify the mathematics that is embedded within their everyday experiences (Boaler, 2002, 2015; Matthews, 2017; Wright, 2017). Wright (2017) suggested that through ensuring links between mathematics and real life situations students' shift from characterising school mathematics as boring and irrelevant to discovering its purpose and appreciating mathematics and its application to real life. Linking learning experiences to life experiences allows students to make connections to their lived social and cultural worlds seeing the purpose and value of learning mathematics.

2019. In G. Hine, S. Blackley, & A. Cooke (Eds.). Mathematics Education Research: Impacting Practice *(Proceedings of the 42nd annual conference of the Mathematics Education Research Group of Australasia)* pp. 196-203. Perth: MERGA.

Both New Zealand based studies and international studies (e.g., Averill, 2012; Hunter & Hunter, 2018, in press; Rubel, 2017; Tate, 1995; Wernet, 2017) have demonstrated that frequently the problematic contexts that students engage with in schools reflect the cultural capital of New Zealand European or middle class white students. Potentially this can mean that students from diverse backgrounds not only struggle with the mathematics within the problems, but also struggle with accessing the context within the problem. For example, in Averill's (2012) study which observed 100 secondary lessons, there was little evidence of teachers drawing on cultural knowledge from their Påsifika parents, students and community to develop culturally relevant contexts that they could use in their mathematics classroom. Similarly, Rubel's (2017) research study set in the USA with 11 teachers who worked in secondary schools with a high percentage of Black and Latino students, revealed that tasks the teachers implemented were related to general out-of-school contexts and were unconnected and irrelevant to the students' lived experiences outside of school. Rubel argued for the need to productively connect mathematics to students' experiences through teachers developing "ongoing practices around learning about their students and their students' interests, everyday activities, heritage, home language and more" (2017, p. 73).

1. Clearly, it is important for teachers to understand the students' cultural backgrounds, to inquire and collaborate with *whanau* (an extended family or community of related families who live together in the same area), and learn about the everyday mathematical contexts from diverse students' home and community contexts that could be used as a basis for tasks in the mathematics classroom (Civil, 2007). Utilising students' funds of knowledge can be used as an essential framework for culturally responsive teaching and equity. Moll, Amanti, Neff and Gonzalez (1992) defined funds of knowledge as "historically developed and accumulated strategies or bodies of knowledge that are essential to a household's functioning and well- being" (p. 3). Within this frame, teachers are repositioned as learners to gain insight into students' and their families' funds of knowledge. Students and families become the experts through sharing their cultural heritage, background and life experiences. Educators who capitalise on this knowledge to create learning experiences and resources for schooling assist equity as students are provided with opportunities to participate in learning experiences that relate to their lived social and cultural world (Civil, 2007; Gay, 2010; Rubel, 2017). The concept of funds of identity where educators communicate and interact with students to learn more about their interests, knowledge and skills complements funds of knowledge and places students at the centre of the learning environment.

Within funds of knowledge models, educators are encouraged to learn about students out-of-school mathematical experiences and use this knowledge to embed everyday mathematics in the classroom. In this way more equitable opportunities can be constructed through drawing on, the knowledge and experiences from the community to bridge the gap between home, community and school mathematics (Averill, 2012; Civil, 2007; Hunter & Hunter, 2018; Rubel, 2017). In the New Zealand context, Hunter and Hunter (2018) described how the use of tasks relevant to students' culture and life experiences resulted in the students seeing a connection between their home and school mathematical lives and being able to achieve while maintaining their cultural identity.

Photographs are a useful tool that educators can use to engage in rich discussions with their students to gather contextualised data about the students' life experiences outside of school (Dickie, 2011; Meo, 2010; Miller, 2014). In the area of literacy, Dickie (2011) provided Påsifika students with cameras to document their life experiences outside of school related to literacy. Students provided teachers with photographs which they shared during rich discussions about the literacy embedded within the photographs. Student engagement increased because the link between home and school literacies strengthened and teachers

developed programs that reflected the knowledge shared by the students. Similarly, this study examined how data collected through photo elicitation interviews with students could be used to inquire into out-of-school mathematical experiences of diverse learners and as a basis develop tasks that align with the students' socio-cultural background and experiences.

Research Design

This paper reports on three aspects of a study which focused on the use of culturally relevant tasks and Pāsifika students' engagement and participation in mathematics. This study worked with 11 Year 5 and 6 Pāsifika students from a decile three urban Auckland school. Ethnically the students were from Niue (18%), Tonga (36%) and Samoa (46%). The study used initial and final interviews to collect students' perspectives of mathematics at home and school. Additionally, students were given a camera to document the mathematical experiences they engage in outside of school. These photographs were used in interviews conducted throughout the study to promote discussion around students' funds of knowledge and understanding of mathematics embedded within their everyday experiences outside of school (Meo, 2010; Miller, 2014). This provided the researcher with new knowledge to work with the students' teachers to design mathematical tasks which contextually fitted with the students. Observations were made of the students working on these tasks in the classroom.

The three aspects of this study that are explored in this research are:

- Pāsifika students' initial perspectives of mathematics at home and school
- Pāsifika students' understanding of the mathematics that is embedded within their life experiences beyond the classroom
- Pāsifika students' final perspectives of mathematics at home and school.

Findings and Discussion

Student Initial Interview Data Related to Mathematics at Home and School

To make positive connections to mathematics, educators can provide students with mathematical tasks using contexts that are relevant to students' interests and enact these in ways that align with their experiences outside of school (Matthews, 2017; Wernet, 2017; Wright, 2017). Questions within the interview explored students' perceptions of their mathematics lessons at school. The initial responses from students (n = 4) illustrated that in their classrooms, mathematics was learnt in an individualised way: *our teacher gives us questions and we go away and have to work it out.* The students' mathematical tasks were often focused on procedures or worksheets (n = 5): *It looks like people just sitting by themselves but when we do activities we do lots of maths sheets for addition (and) division.*

Further questions investigated students' experience and use of mathematics outside of schooling contexts. Students demonstrated difficulty in recognising or describing the mathematical experiences that they engaged in outside of school. Students who responded to this question (n = 3) linked the mathematics they do at home to completing homework: *Yeah, you do homework at home and your mum can try help you.* One student responded to this question by describing mathematics work provided by a sibling: *sometimes I have to get off the technology and my sister will sit there until we finish and she'll give us really tricky questions.* Overall, the student responses indicated a view of mathematics as only related to a school context.

Analysis of the student responses in the initial stages of this study provided a window into their mathematical learning experiences which appeared to represent a traditional style of teaching where students worked individually to complete worksheets or other similar routine tasks. Similar to the findings of previous research (e.g., Boaler, 2002, 2015; Matthews, 2017; Wright, 2017), students viewed mathematics as working out the answer to a procedure rather than linking the mathematics they do in school to real-world experiences. These perceptions could be attributed to their classroom experiences. It appeared that like findings represented in both international and New Zealand based research (e.g., Averill, 2012; Hunter & Hunter, in press; Rubel, 2017; Tate, 1995) the classroom context in the current study did not align with these diverse students' experiences outside of school or within the community.

The student responses highlighted a disconnect between the students' lives outside of school and mathematics. The students were unable to see the mathematics embedded in their everyday lives and viewed mathematics as only related to school contexts. A divide between what is learnt in school and the mathematics that students experience in the real world has been well documented by researchers (e.g., Boaler, 2002, 2015; Cobb & Hodge, 2007; Gay, 2010; Wright, 2017). These researchers explain that when a classroom mathematics program does not reflect real life contexts that connect to students' lives, then students' struggle to develop an appreciation for mathematics.

Exploring Students' Funds of Knowledge Through Photographs

Over the course of the study, students both took photographs with cameras supplied by the researcher (n = 25) and brought in existing photographs to share (n = 27). Photo-elicitation interviews provided a format for students to provide descriptions of the mathematics that was embedded within activity represented in the photograph. The photographs and information collected through these discussions were used as a resource to design mathematical tasks that were implemented in the classroom. Frequently, students described multiple mathematical strands for a single photograph. The following sections unpack the instance of measurement, number, geometry, and algebra identified by the students and provide examples of the descriptions given by the students. Interestingly, statistics and probability were not identified by any of the students.

Measurement

Most commonly, student responses (n = 85) identified instances from out-of-school mathematical experiences where measurement would be used. For the responses categorised as measurement, the most common response referred to forms of linear measurement. For example, Manaia began by sharing a photo of her *pule-tasi* (traditional Pacific Island dress). She then described how cultural artefacts were made: *everything is handmade...the dresses are made by my grandma. All my birthdays I have a tapa cloth (handmade cloth made from bark) that my grandma made.* She identified the mathematics embedded in this as: *how much material is needed to make the dress? What length is the dress?* Other examples of linear measurement included descriptions of mathematics related to distance and also to height. Time was another commonly used example of mathematics in relation to how long it takes to travel on family trips and measuring how long it takes to complete activities. For example, Kelly brought in a photograph of Rarotonga and described how it linked to mathematics: *How long was our plane trip from New Zealand to Rarotonga?*

Frequent reference was also made to money, specifically calculating the cost of items. An example of this is when Joseph described how making an *ula-lole* (traditional Pacific Island necklace made out of lollies) linked to cost: *counting how much money you will need at the shop to buy the materials and lollies* and also referred to calculating the cost when

celebrating his Mother's birthday at Valentines: *how much it cost for all of the guests?* Other areas of measurement included mass and volume. In referring to the mass of objects, one student referred to Påsifika mythology to describe a legendary rock in Tonga: *This is a volcanic rock. This is from centuries ago when our god Maui. He ummm well I'm not sure if it is a legend or not but he woke up one morning and heard a lot of roosters and he keeps on getting annoyed and found a big rock and threw it at the roosters.* The mathematics embedded in this was described as: *How much does it weigh?*

Number

Sixty of the student responses highlighted the everyday use of number within their lives. Descriptions of the use of multiplication in relation to food preparation or catering for guests was prevalent in student responses. The photographs provided a basis to talk about commonly made dishes. For example, Richard brought in a photograph of him making *panikeke* (a traditional Samoan pancake) and shared his perspectives of the mathematics involved: *This is a picture of me baking at my Samoan house. How many doughnuts are there on the tray?* Similarly, Joseph described how making an *ula-lole* involved multiplication: *How much lollies in one pocket? We made one with three lollies in each pocket so we thought we could do a question that involved how many lollies. We have nine pockets so it could be nine times three.*

Addition was identified in 26 of the student responses as mathematics embedded in students' experiences outside of school. To illustrate this, Kayden brought in a photo of him playing rugby league and shared how addition would be included: *How many tries and tackles there were in the game?* He also mentioned how subtraction could be involved: *working out the difference in the teams scores.* Division was used in relation to sports team organisation, sharing food and road trips. For example, Richard shared a photograph of a family road trip. He describes how division is embedded: *How many passengers on the road trip so you would have to know how many cars you would need?*

A small group of student responses identified the everyday use of fractions, proportions, and ratios within their lives. Students linked fractions to their experiences of sharing out dishes they have cooked with family members or to making cultural artefacts. For instance, Kelly shared how she could use fractions when making lasagne and chocolate brownie for her family: *How can we divide the brownie and lasagne to feed eight people?* Additionally, a number of references were made to the use of proportions and ratios. For example, Manaia brought in a photo of a traditional feast stating: *Here you can see there are lots of trays right? There were lots of guests. How much food would they need? How much coconut and taro leaves would they need to feed all of the guests?* Similarly, Kayden shared a photograph of him giving his infant cousin a bottle. He described how ratios were involved in this experience*: the amount of milk and water in the bottle.*

Geometry

Less commonly, (n = 11) student responses highlighted the use of geometry within their lives. Students identified shape in relation to objects that they visited on family outings. For example, Joseph shared a photograph of his family outing viewing large boats and provided examples of mathematics that linked to shape: *How many shapes are on the boats because there are a lot of shapes used on boats like cylinders and rectangles.* Students identified angles in relation to cultural dances, sports and leisure activities. Illustrating this, Manaia described how dance moves linked to angles when sharing a photograph of her dancing: *the angles and I am like on a different angle here.* Students also made links to position and orientation. Kayden described angles and directions when sharing his experience of driving a bumper car: *So angle of turns and amount of cars bumped and different directions.* Joseph associated these strands of geometry to playing rugby league: *Angles - each person has their*

own position. Some people are standing here and are facing on this angle to face the other team. Directions - where and what direction they run.

Algebra

A small number of responses referred to algebra and all of the responses related to patterns. Student responses that referred to patterns were often general and although students mentioned patterning, it was apparent that they found it difficult to identify this area of mathematics within their photographs. For example, Joseph in discussing his rugby league team shared his perspectives of the mathematics he thought was embedded with the uniform: *How many patterns on your uniform*? Manaia shared how she thought patterning would be included in music while she played for the orchestra: *How many times you have to breathe because you need a lot of air? And like.....How many beats? How many pieces of music?* Interestingly, the majority of the discussion was about mathematics that was constructed around the artefact instead of the mathematics embedded within cultural actions or artefacts. For example, Manaia did not mention the patterning involved in the hand movements of dance or the algebraic patterning in the design of cultural artefacts such as *tapa* or *pule-tasi*.

Drawing on the analysis of the photo-elicitation interviews, it is evident that over the course of the study, students were beginning to develop some understanding of the mathematics embedded in their everyday experiences. This could be described as emerging because although the students identified many different strands of mathematics, their perceptions were still tied closely to the mathematics which they observed on a surface level rather than the more complex mathematics involved in everyday situations. The students struggled to describe the mathematics that was embedded within the artefact and on many occasions described only the mathematics that surrounded it or gave responses that included contrived mathematical situations reflecting 'school' mathematics type problems. It is clearly evident from the data, that at this stage they were not bringing an indigenous perspective to the mathematics within the cultural artefacts. Previous research studies (e.g., Averill, 2012; Hunter & Hunter, in press; Hunter & Miller, 2018; Wernet, 2017) have highlighted the importance of developing the use of authentic tasks in the classroom that encapsulate the mathematics grounded within students' cultural and lived experiences and perspectives. These researchers argue that this can support students to acquire a better understanding of mathematics and its value to the world that is most important to them.

Student Final Interview Data Related to Mathematics at Home and School

The final interviews showed a shift in student awareness of the mathematics that they engage in outside of school. All students (n = 11) were able to provide examples of mathematics that they use in their everyday life. Most commonly, students related the use of mathematics at home and in the community to food. This use included both sharing food: *So you can divide stuff equally like pizza for dinner* and cooking: *Baking and cooking and stuff because you need to measure the ingredients you need and measuring them out.* Other students linked mathematics outside of school to financial experiences: *Going to McDonalds and my mum gave me money and I had to take a certain amount of money to the people and I did not want them to rip me off, so I had to work out how much change I would need.* Similarly, Joseph shared the importance of mathematics for paying bills: *like how much my parents are paying for bills.*

It appears that using photographs from the interviews as a resource to design mathematical tasks strengthened the relationship between mathematics learnt at home and school. In contrast to the initial interviews, students were now confident at describing where mathematics was used in their lives outside of school. Their perceptions were transformed

from seeing mathematics as numbers and homework to identifying real life situations where mathematics was used. Previous research studies (e.g., Civil, 2007; Dickie, 2011) also have highlighted the success of using photographs from home and community settings and discussions of these as a resource for task design.

Conclusion

The research literature highlighted that when students engage in learning experiences in the classroom that align with the mathematics they use outside of school, they will see a purpose for learning mathematics and its benefits to their current and future lives (Boaler, 2002, 2015; Matthews, 2017; Wright, 2017). In the initial phase of this study, many of the students struggled to describe the purpose for learning mathematics and could not explain how they used mathematics outside of school. It became apparent that the learning experiences students were participating in their classrooms did not reflect the mathematical experiences of their lives beyond the classroom. In response to this, students shared their out-of-school mathematical experiences using photographs. They engaged in rich discussions with the researcher about their culture and the mathematics embedded within their experiences (Civil, 2007; Dickie, 2011; Miller, 2014). Interestingly, many of the students could not describe the deep mathematics embedded within their cultural artefacts and experiences. They could only identify surface level mathematics that surrounded them.

Students' photographs of their mathematical experiences were integrated into their mathematics classrooms using them as contexts for mathematical tasks. The students' perspectives in the final interviews align with those outlined in Hunter and Hunter's (2018) and Wernet's (2017) studies in which these authors suggested that utilising students' interests and experiences for task design, enables students' to link mathematics learned in school to real-world experiences outside of school.

Findings from this study highlight the need to investigate how students can be supported to unpack the deeper mathematics that is embedded within life experiences. Although, it was evident in the study that students were beginning to identify mathematics outside of school, it would be helpful to extend this finding further. The evidence suggests that using mathematical contexts that link to students' lives beyond the classroom can assist equity and bridge the gap between home and school mathematics.

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