Developing Equitable Participation Structures

Roberta Hunter
Massey University
r.hunter@massey.ac.nz

Jodie Hunter
Massey University
j.hunter1@massey.ac.nz

Participation structures are important in relation to who gets equitable access to mathematics within classrooms premised on co-construction of mathematical reasoning. This paper takes a strength-based focus to explore how two teachers extended their Pāsifika students' known repertoires of practice to encompass others, which supported them to better engage in mathematics. The data illustrates the importance of teachers drawing on task contexts and student ways of knowing and being to facilitate student engagement in reasoned discourse and argumentation. The teacher actions provide a model which other teachers could draw on when teaching mathematics to students from predominantly collectivist groupings.

In mathematics who participates and how is closely aligned with who and who does not achieve mathematically. Aotearoa/New Zealand like many other countries have particular groups of students who fit into this category of underachievement, including a large number of Pāsifika and Māori learners (Hunter & Hunter, 2018). Within this paper we propose that these low levels of achievement can be directly attributed to the participation structures many Pāsifika and Māori students encounter in our mathematics classrooms. We contend that these should be addressed as a key equity issue.

Core to participation structures is recognition of the significance of all students being able to actively engage in the reasoning of others through participating in collaborative mathematical discussions. Educators, researchers, and policy makers alike verify the importance of co-construction of collective understandings to advance rich and deep mathematical knowledge (Civil, 2014; Franke et al., 2015). Co-construction in mathematical activity asks for interdependence of students contributing both individual and shared knowledge, strengths, and perspectives (Calor et al., 2019; Kaendler et al., 2015). However, when considering the required interactive collaboration many factors need to be considered, not the least being close examination of equitable ways for all students participate. There appear to be a paucity of papers which specifically explore equitable participation structures which draw on the background of students from collectivist societies' ways of *knowing and being*. To this end, in this paper we take a sociocultural perspective to examine and explore how diverse learners from collectivist societies can be scaffolded to draw on their ways of knowing and being to collaboratively co-construct mathematical understandings. The question we ask is; what are the actions teachers of students from collectivist societies (in this case Pāsifika students) take, to scaffold these students to build on their own collectivist strength-based participation patterns in mathematics lessons?

Literature Review

In this paper, we take a sociocultural and situative frame and a strength-based perspective rather than what Valenzuela (1999) describes as a subtractive focus. Valenzuela suggests that within a subtractive model the dominant cultural group's ways are assumed to be the only ways of *knowing and being*. As a result, the cultural and language backgrounds of those from non-dominant groups are seen as problems not resources. As a direct result many non-dominant communities adapt to ways of *knowing and being* of the dominant cultural group giving up their own known and successful interaction patterns. In a subtractive model subtle messaging related to what represents a normatively appropriate person in schools and classrooms suggests concepts of self as independent and self-reliant (Stephens et al., 2012). For many Pāsifika

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students in mathematics classrooms in Aotearoa their concept of self, causes them dissonance with normative expectations as independent beings in the school environment and interconnected and interdependent beings in the home context (Hunter & Hunter, 2018). Hunter and her colleague reported how these students described a negative sense of self and their culture when expected to work within ability mathematics grouping premised on individualism and competitiveness within the school setting. In contrast, these same students reported an increased positive sense of well-being when working within heterogenous multi-strength-based groupings in collaborative co-construction of mathematical reasoning.

A strength-based approach supports notions of drawing on communities' cultural strengths resulting in building towards more flexibility in ways of *knowing and being*. This includes not only drawing on mathematics tasks which are contextually appropriate but also developing different ways for interacting while doing mathematics. Supporting students to build on and extend from what Rogoff and colleagues (2017) describe as their repertoires of practice (as those known within their community setting) the students are enabled to be more adept at selecting which repertoire of practice is appropriate to other contexts. In examining the cultural strengths of Pāsifika children raised within a collectivist world, a key emergent element is an expectation of them working together in collaborative ways. From a very young age these children, within their homes are expected to take the initiative in many key aspects of family life including cleaning, food preparation as well as some economic activity (Hunter, 2021). Most often these collaborative interactions and reciprocal responsibilities are learnt at the knees of elders (Alefaio, 2019). Alefaio describes how respect of elders underpins close listening and watching by younger community members as they learn communal patterns of interactions. Alefaio outlined how very young Samoan children took responsibility for younger siblings and inducting them into learning how to do household tasks as integral to supporting the family.

Family is a core value. Encompassed within this Pāsifika value is a sense of family, as thinking and working as one unit rather than as individual members of the unit (Hunter & Hunter, 2018). Rogoff and colleagues (2017) describe these ways of *knowing and being* as sophisticated collaboration. These researchers describe how they observed children from indigenous backgrounds in the Americas as they co-constructed thinking through building on each other's ideas to progress a collective goal. Alefaio (2019) also described how Pāsifika children achieved collective progress with little discussion but through close watching and noticing the activity of each other. All these researchers describe how such actions supported the children to adapt and align their own activity towards a shared goal almost synchronously as one. This contrasts with observations made by Rogoff and colleagues of middle-class European American children. Although these students were tasked with working collectively, they tended to work as individuals within the group, allocating separate tasks and not attending to the activity or thinking of each other. Therefore, conflict developed when asked for a shared response as each individual child competed for acceptance of their own ideas.

Establishing mathematics classrooms where all students actively participate in collaborative co-construction of reasoning requires social norms based within the relational trust and reciprocal respect found within families within the collectivist frame. Researchers (e.g., Fletcher et al., 2011; Tamarua, 2006) described how Pāsifika students in their homes learn through collaborative reciprocal relationships and when interviewed stated that they would prefer to learn in this way at school. Hunter and Hunter (2018) and Civil and Hunter (2015) illustrated how Pāsifika values set within this perspective of family, support other important interactive factors needed in mathematics classrooms structured in that way. They showed how mutual trust and respect founded within notions of how families interacted with each other, provided students with room to ask each other challenging questions, to engage in mathematical agreement and disagreement, be safe to take risks and make mistakes, and use humour and small talk to reduce tension. Hunter and Hunter showed the importance of

establishing productive mathematical discourse within Pāsifika values. They illustrated how through building on the students' own language, mathematical argumentation became 'friendly arguing'. They explained how this resulted in students perceiving this type of arguing as positive and focused within on the mathematics, and not on a person.

Nevertheless, we know that asking teachers to build such mathematics classroom environments is challenging particularly given the paucity of models, teachers have access to, of how these might look. However, their importance is critical as a key equity issue to support all students to access participation structures in mathematics classrooms. So, our aim in this paper is to provide one possible model of how two teachers scaffolded their students to build and extend their repertoires of practice through using their family-established strength-based interaction patterns to co-construct mathematical reasoning collectively in the school setting.

Methods

The research reported in this paper is a small section of a large on-going longitudinal project which has spanned more than fifteen years in Aotearoa/ New Zealand. Participants in the larger project over that time, have included more than 2000 teachers and their students in urban primary schools. These schools are set within low socio-economic communities with a high proportion of Pāsifika nations' students in attendance. The teachers come from diverse backgrounds and have varying teaching experience. The two teachers selected to report on in this paper, were both experienced and of mixed European and Pāsifika nation's heritage but born and schooled in Aotearoa/ New Zealand. The students were predominantly Pāsifika and aged 9–10 years.

Data collected across the project included video recorded classroom observations, field notes, questionnaires and teacher interviews.

The two teachers selected and reported on in this paper were chosen as a representative sample of the common culturally sustaining (Paris, 2012) pedagogical practices observed in a larger set of classrooms. To select the initial set of teachers the first researcher had reviewed a wider selection of teacher video records and from these she narrowed the focus to a smaller group of teachers and students who showed specific attributes the two researchers had agreed upon. The analysis of the larger teacher video records consisted of comparing and contrasting actions and responses and from this developing codes. From the codes emerging themes and patterns were identified which directly related to culturally sustaining pedagogical practices and which were consistent actions across the different teachers and their students.

Findings and Discussion

The classroom mathematics lessons consisted of pedagogical practices embedded in ambitious mathematics teaching (Kazemi et al., 2009) and culturally sustaining practices (Paris, 2012). This open and flexible pedagogy was premised in teacher noticing and responding to both student's reasoning and their participation patterns. High level, challenging and group worthy mathematics tasks (Featherstone et al., 2011) were used, rewritten within known Pāsifika contexts. Lessons followed a pattern promoted by Smith and Stein (2011). Each lesson followed a similar format where problems were launched and social norms discussed, then students worked in small groups of four to co-construct mathematical solutions. Lessons ended with large group sharing session of sequenced student explanations, discussion founded in inquiry and argumentation and ended with connecting to a big mathematical idea.

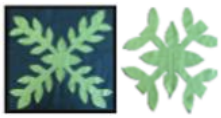
Making Cultural Connections Through Tasks

The two tasks selected both had close links to activities in the local community, to ensure that students did not struggle with both context and the mathematics. Teacher 1 used a task that linked to a local night market and food commonly sold at this market as family fundraising.

Task 1: Aliyah and her cousins are helping their family sell topoi (Fijian Indian dumplings) at the market. They sell the topoi in big polystyrene boxes to people who are having a family celebration. In each box the girls are told to put 26 topoi. If Aliyah's mother and her aunties between them have cooked 425 topoi. How many boxes of topoi will they have to sell? How many will be left over for the girls to eat?

Teacher 2 selected a task that involved the making of a tivaevae (bed quilt). Making these is an enterprise embedded in family and wider communally based activity well known within Pāsifika nations peoples and is an item with patterns common within most of their Pāsifika students' homes.

Task 2: A group of Mamas are working on a tivaevae design.



This is the 1st position

This is the 2nd position

This is the 3rd position

How many leaves does it have? How many leaves does it have? How many leaves does it have?

They would like to turn the pattern from the cushion cover into a bedspread. Can you help them work out how to keep the pattern the same?

Talk in your group about how you notice the pattern growing. Can you represent what it looks like using numbers? Think about how many leaves would the 6th position have?How many leaves would the 12th position have? How many leaves would the 51st position have? Can you come up with a rule to find out how many leaves there would be in any position?

The two teachers began by launching the task with an immediate emphasis on ensuring that all students had access to the context. Both ensured that they gave voice, as well as intellectual ownership of the cultural context, to specific students who came from the island nation the problem related to. For example, teacher 1 asked a Fijian Indian student to elaborate on making and eating topoi. Then she extended discussion to have Vietnamese students describe similar Vietnamese dumplings and Cook Island students describe coconut buns. She included other students sharing their experiences of buying and selling food at the night market and the way in which rectangular polystyrene boxes were used for transport and storage. Through close listening and responding to student explanations she gradually drew out important points which would support the students to construct a mathematical explanation. Finally, she shifted discussion to the mathematics and collectively the group agreed on what the problem was asking them to do (find out) without her providing any hints or suggestions of procedures.

Using similar actions, the two teachers ensured that all students could not only relate to the contexts but were able to see mathematics as alive and relevant within their lives beyond school mathematics. The challenge of the tasks was maintained but at the same time their group-worthy features required a multi-strength approach to solve (Featherstone et al., 2012). Featherstone and colleagues promote need for tasks which call on a range of different attributes from group members and which need to be pooled to gain collective solutions. These tasks

fitted well within this criterion. Using tasks in this way go some way towards constructing a learning environment which draws closer to the home learning environment of many Pāsifika learners described by Fletcher and colleagues (2011) but which also build their mathematical disposition.

Using the Contexts of Tasks to Establish Social and Mathematical Norms

The very essence of the problems was set within family and community contexts which involved collective action and modelled communal problem solving. This gave both teachers an opening to draw on known ways these Pāsifika students worked together at home to establish the required social norms for group interactions in the mathematics lessons.

Both teachers referred to how the families in the problems worked together as a collective. Teacher 1 used the context of the problem in establishing her independent mathematics groups: "Today you are going to work together like you do in your family, like Aliyah is doing." Then she discussed with them in more depth the different roles the individual members had in making, packing, and selling the topoi and the way in which they were all dependent on each other for the final product and sale.

Teacher 2 also referred the students back to the way in which all the mamas worked together in making the tivaevae from cutting through to sewing the complete bedspread. Both teachers emphasised that at the completion of the tasks the ownership was shared rather than individual. For example, teacher 2 told her students:

> So, think about how you are going to work together today in your small mathematics groups. You are going to really need to listen and watch really carefully and depend on each other to explain and answer questions and get your shared solution like your mamas do when making things like mats and a tivaevae. That is because what your group explains in our sharing group it will be all your shared thinking put together just like those beautiful tivaevae share who your family are.

These actions provided the students with opportunities to explore the mathematics through drawing on a repertoire of practice (Rogoff et al., 2017) they were familiar with in their home context, but which is not common in New Zealand/Aotearoa classrooms. The close watching and listening as another way to learn mathematics, Alefaio (2019) described as the way Pāsifika children from a very young age learnt to participate and contribute within collective family activities.

Both teachers also drew on aspects within the contexts of the problems to establish other mathematical behaviour they were currently promoting in mathematical activity. For example, Teacher 1 extended the discussion to include a focus on student need to ask challenging questions and their need to engage in mathematical argumentation when she asked: "But if one of the Aunties doesn't put enough flour in, or Aliyah starts to put topoi just anywhere in the box, what would you do?" After listening to the students as they offered their ideas, she pressed the focus towards how she wanted them to engage in the mathematics:

> I know that all of you sometimes hold back when asking each other hard questions or challenging thinking because you worry about losing mana (status or loss of face) or them losing mana. But you do not need to worry, it's not about anyone it is about the maths and the thinking, and you do it in a respectful way, a polite way like you would at home. You really need to ask for more explanation or justification because that is what doing maths means but do it in a way that Aliyah's family or Aliyah would do with friendly arguing, but you are doing it about the mathematics.

In this way, she established their need to shift past their own reticence to ask each other questions that challenged reasoning even when they worried that the explainer might not be able to respond.

In a similar manner Teacher 2 used an aspect of the problem to engage the students in thinking about how they might consider making errors as a learning opportunity for the whole community. She began by talking about a time when she was involved in sewing a section of

the tivaevae. Her stitches were uneven and one of her aunties had got her to unpick a section and resew it but in doing so had modelled and explained carefully how to redo it so that she felt that her mana was intact. After she explored what would happen if she had not been supported in this way, she asked "how is this similar to working with your group during maths?" The students identified that if they disagreed with an idea, they could then rework the solution. Continuing the discussion, she then outlined the similarity between making the tivaevae and co-constructing a mathematics solution in saying:

> Remember a tivaevae is a taonga (treasure) and so if you do not tell someone that they are making a mistake it ruins the beautiful gift. Well, it is the same in maths and when you are working together. If you don't tell someone when there is a mistake, then your explanation, your gift to all of us will be ruined and you have lost the opportunity to learn more together.

Through such actions these teachers inducted their students into use of productive discourse while all the time they remained cognisant of their need for comfit to shift between culturally accepted interactions and those required within productive mathematical interactions. Both teachers were grounding the need for productive mathematical discourse within relational trust and reciprocal respect (Fletcher et al., 2011; Tamarua, 2006). As Civil and Hunter (2015) and Hunter and Hunter (2018) previously described, these values are key to providing Pāsifika students with opportunities to engage in participation structures which support them learning rich and deep conceptual mathematics.

Maintaining the Social and Mathematical Norms during Group Activity

As the students worked together collectively within their independent small groups of four the teachers monitored both the mathematics and the participation of the students. Focus was maintained on how they engaged in questioning and challenging their reasoning. They were frequently heard to comment out loud at what they observed. For example, Teacher 1 says:

> Great, Tasa I just heard you ask a good question and that helped everyone make sense of what Katalina is saying. I saw you hesitate for a moment and that is okay because then you asked in a way that was respectful of Katalina and gave her a chance to explain or have others in your little family add bits and altogether you had some great thinking.

In this way, the press on productive discourse was maintained but students were able to see that it was all right for them to feel a sense of reticence, but they needed to work through it.

Teacher 2 also continued to monitor the participation, but she also built on their patterns of interaction which supported co-construction of reasoning embedded within the mathematics as it was developing. For example, she closely observed them as they examined the pattern:

> Student 1 records +8 on their sheet as she says: It adds by 8.
>
> Student 2: But it has 4 in the middle.
>
> At this point student 3 takes the pencil and draws the pattern as he explains: Every time you add on you plus 8.
>
> Student 2: What about for position 7?
>
> Student 3 explains as he circles one group and adds dots for more: It would be 7 groups of 8.
>
> Student 4 has been silent but watching closely and now he takes the pencil, and records 7 x 8.
>
> Student 1: But what about the four in the middle?
>
> In response student 4 writes + 4
>
> Student 2 then points at the final recording on the sheet, and she asks: So what were we thinking there?
>
> At this student 1 picks up the pencil and uses it to link the pattern student 3 drew to the recording of +8 as she explains: Well, we started by saying that it was plus eight and plus 4 but we realised that we can just as easily go seven times eight…

Student 3: And we didn't forget the middle so plus four all the time.

The teacher has been watching without speaking and now she says loudly: It has been great watching how you are working together and really watching so closely everything anyone else says and does and listening to each other but also great question about what you were thinking because then you all had to check out your understanding of your explanation together.

It was clear that these students were almost acting together in a symbiotic way evidenced by the use of the word "we" used normatively. Rogoff and colleagues (2017) described such interactions as sophisticated collaboration which they observed within students from other communal societies. Few words were spoken but each student totally engaged in the actions of other's and through this process co-constructed their group explanation. The teacher recognised this way of interacting as important and chose to highlight this for the other students. In this way she provided permission for all students to work together collectively in whatever way they found comfortable but also constructive in their mathematics learning.

Conclusions and Implications

We began this paper with the assertion that one possible reason for lack of achievement for many Pāsifika students can be attributed to the participation structures of mathematics classrooms in New Zealand/Aotearoa structured on those of the dominant cultural groups. As part of embracing equitable practices which are culturally embedded, we argue the need for teachers to also consider other forms of participation structures possible. This requires teachers to consider what is often outside their own experiences, but as this paper shows is needed and can be achieved.

The concept of family within a Pāsifika view has an important role. As the students stated to Fletcher et al. (2011) their preferred style of learning was within and as a group. Like the students in this study this reflected their preference for their own ways of *knowing and being*. In this form of learning this was comprised of them acting as one organism and co-constructing mathematical reasoning through sophisticated collaboration (Rogoff et al., 2017). Through the teachers supporting their interactions based on their home and community ways of being, they were able to engage in a positive strength-based approach rather than what Valenzuela (1999) described as a subtractive one. Their normative sense of being as a symbiotically interconnected and interrelated units was maintained, rather than them experiencing the more commonly known within mathematics classrooms in New Zealand/Aotearoa of a normative sense of sense of self as independent and unrelated (Stephens et al., 2012). Considering family as a collective operating as a single cell or organism calls for teachers to integrate their own views of how the family operates as a unit. Implications suggest that the expected norms of students working independently within mathematics activity needs direct addressing so that all students have opportunities to engage in ways which better match their own cultural values.

Throughout both lessons the teachers pressed for productive mathematical behaviour by building on their known ways of *knowing and being* embedded within aspects of the problems. Both teachers adapted appropriately challenging mathematics problems from a website which they then rewrote within their students' cultural context. This needs to be part of teacher planning where an equitable action would be for them to consider both who the context relates to, and how they can use the problem context to engage all students. Careful consideration of this would avoid a situation often seen in classrooms where Pāsifika are often left to struggle with both the context and the mathematics (Hunter & Hunter, 2018).

The teachers' explicit talk supported the students to engage more readily in reasoned mathematical discourse and argumentation. In previous research Hunter and Hunter (2018) outlined the diffidence many Pāsifika students showed when asked to question or disagree with the reasoning of their peers. In these classrooms, the teachers clear focus on issues of mana allowed students to move past these feelings of whakamā (sense of shame and loss of face). As

Rogoff and colleagues (2017) argue, all students need to be able to select an appropriate repertoire of practice flexibly and adeptly in classrooms. This is what these teachers were ensuring through their deliberate talk and actions; the students were being given opportunities to extend from their known repertoire of practice to become more adaptive within those most often encountered within classrooms in New Zealand/Aotearoa. However, for both groups of students it was made clear that their ways of *knowing and being* were seen as strengths and this enabled them to select how they functioned within the mathematical discourse. Taking a strength-based focus has a lot to offer those students so often inequitably positioned. There is a lot of work to be done but as this paper shows, it is achievable.

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