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Bridging language barriers in statistics for Year-12 Pasifika students: A collaborative study

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Abstract

This paper focuses on the use of home languages as a resource for Pasifika students who are learning about statistical methods. It is acknowledged that there are connections between language use and mathematics in mathematics learning and teaching, and the potential challenges this issue can pose have been investigated by researchers. Yet how the challenges of the use of home language versus teaching language might be overcome in statistics classrooms, where language is even more important as a medium of instruction, has received very little scrutiny. This article reports on research carried out in three New Zealand largely Pasifika dominated Year-12 classes. Data was collected from audio recordings of student group discussions and teacher reflections while students were carrying out an investigation of existing datasets. Findings from the teacher reflection aspect of the study indicate that teachers can struggle with how to use home language and real-life contexts to maximise learning in their classroom. Some strategies to incorporate students home language in their learning worked better than others. However, more in-depth research is needed to explore language issues and the barriers they might present in statistics education.

Keywords:

Statistics education, linguistic challenges, everyday language, statistical language, collaborative research, connecting language and statistics, Pasifika students, language strategies

Introduction

> I: What is the range of this dataset? (1, 2, 3, 4, 6, 6, 13)
>
> S: Seven
>
> I: Okay how did you get that?
>
> S: Just the number of the elements.
>
> 1: How many values in the above dataset are at most six?
>
> S: One. The only number that is greater than six is 13.
>
> (Lesser & Winsor, 2009, p. 12)

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A common view about mathematical language is that it is a culture free, universal language (Brown, Cady & Taylor, 2009; Meaney, 2006). However, as the above quotation illustrates, the language of mathematics and statistics is intrinsically cultural, which can be confusing and very challenging (Lavy & Mashiach-Eizenberg, 2009). In the quotation the everyday usage of the term 'range' can suggest 'ranging through' the 'full range of' elements of the dataset, thereby evoking the concept of sample size. However, it is also possible that the student's use of all the numbers in the dataset as indicated could equally reflect their interaction with a mathematics register in which the word 'range' is generally used to indicate a set of numbers rather a single number. Students accustomed to using a reflexive 'keyword association - e.g., treating 'at least' as 'less than' and 'at most' as 'more than' - may make errors interpreting a question such as 'How many values in the above dataset are at most six?' It is not just the meaning of words used *within* a statistical context that can be confusing. While some terms have different meanings in everyday usage and in statistics, some are also used in mathematics in more than one way (Kaplan, Fisher & Rogness, 2010; Lesser & Winsor, 2009). A useful example of this point is the use of the word 'significant'. This term has one meaning in ordinary English, a second in mathematical English (when thinking of significant numbers), and a third meaning in statistics. Grappling with how language is used in statistics can present challenges for any student (Kazima, 2006; Lesser & Winsor, 2009). However, to understand mathematics in an English medium classroom, English second language learners may have to undergo more processing than native English speakers (Barwell, 2012; Kazima, 2006; Latu, 2005; Meaney, 2006). Students must simultaneously learn ordinary English and mathematical English, and to be able to differentiate between these two types of English language use (de Oliveria & Cheng, 2011; Moschkovich, 2005; Schleppegrell, 2011). In statistics, classes learning up to three types of English usage can become necessary.

More than half of Pasifika peoples in the seven largest groups in New Zealand were born overseas and speak English as a second language. Pasifika students have been identified as the most at-risk group in New Zealand in terms of academic achievement, particularly at the secondary school level (Alton-Lee, 2008; Ministry of Education, 2013a, 2013b). These two points are significant given research indicating that there is a relationship between students' proficiency in the language used for teaching and assessing mathematics and their attainment level in this subject area (Barwell, 2012; Xi & Yeping, 2008). Research has found that students who have a high level of proficiency in their first language and who develop a similar level of proficiency in the classroom language tend to out-perform monolingual students in mathematics. In contrast, students who do not develop a sufficient level of proficiency in any language tend to underperform in mathematics, Currently, the idea of a cultural deficit is fused to explain this under-achievement, with Pasifika cultures being positioned as particularly mathematics deficient (Turner, Rubie-Davis, & Webber, 2015). In New Zealand, the remedy for underachievement in mathematics is to try to transition (non-English) first language students to learning completely in their second (English) language. In this scenario, active use of other languages is seen as a hindrance rather than a help.

A number of international agencies, including European Commission (2015). and UNICEF, 2016) recognise the contribution that multilingual education can make to engaging diverse learners. In addition to supporting their academic achievement, using multiple languages can also assist students in the development of positive identities associated with their home culture (European Commission, 2015; UNICEF, 2016), which is a basic human right. Mathematics education research has identified that a student's first language(s) can serve as a resource for thinking and communication as students simultaneously learn and develop proficiency in the language of instruction and learn mathematics (Parvanehnezhad & Clarkson, 2008; Planas & Civil, 2013). However, this idea has yet to be thoroughly tested in New Zealand mathematics classrooms. This paper begins by reviewing the literature that informed our collaborative study, designed to probe the idea that first language use is helpful for English second language students who are learning about statistics in their classes. Section two describes the design-based research study conducted at one school while section three presents key findings from the study. These are then linked back to relevant literature. The final section offers suggestions for teaching and further inquiry in this area. In this paper, the term English Language

Learners (ELL) is used to denote someone who does not have the fluency of a native English speaker so to fully participate in mainstream English instruction (Goldenberg, 2008). This term can also include those who are proficient in English but may need additional support in social or academic situations.

Literature Review

Recognising the importance of first languages

Multilingual classrooms are an increasing feature of schools worldwide, in part due to immigration as a response to poverty and war, and also because of efforts to maintain minority or indigenous home country languages (European Commission, 2015). Classrooms deemed to be multicultural are places where learners have different linguistic and cultural backgrounds. In multicultural classrooms, students may speak one language at home and another language at school, teachers and students may not share a common language or cultural background and some or all of the students may be learning the language of instruction as a second language. Responses to multiculturalism related to language use can vary. Planas and Setati-Phakeng (2014) describe three perspectives that impact on the development of language policies and multilingual classroom practices: language-as-problem, language-as-right and language-as-resource. The language-as-problem perspective considers language as something that creates challenges that need to be resolved. In this view, teachers may view students' limited English as a limitation to be overcome through a focus on intensive language teaching. Language-as-right emphasises the protection of minority language groups since everyone has the right to be educated in her/his home language. These authors further note that while language-as-right supports the use of the students' home languages as the language of learning and instruction, this initiative is often paired with the stigma of the home language being a 'non-English' language. Here pedagogical strategies and policies based on language-as-problem and language-as-right can have unintended effects on different language groups of students by decreasing their access to classroom learning opportunities and interaction. In contrast, the language-as-resource perspective addresses both the stigma and the problem by actively encouraging the use of multiple languages during mathematics teaching. Planas and Setati-Phakeng (2014) see a language-as-resource approach as increasing the learning opportunities of all learners by focusing on both mathematics and language as being connected in the teaching and learning process.

Research in multilingual mathematics classrooms

Research into what happens in multilingual mathematics classrooms has produced some intriguing results. Plana and Civil (2013) report that teachers and students switch between languages in mathematics lessons because learners communicated their mathematical thinking more easily in their home language. Further, this switching improves mathematical dialogue in the classroom. Similarly, Parvanehnezhad and Clarkson (2008) have found that language switching helps students understand the context of a question. For example, when solving a word problem involving time, one student was confused between am and pm, so they used Persian language to understand the context in which the problem was located. Further, Clarkson (2007) reports that language switching helped Vietnamese students gain more confidence and hence enhance their mathematical learning. In a Pacific context, Latu (2005) has found that Pasifika students find it helpful to switch between languages in an effort to understand symbols such as > and <. Yet the use of the home language does not always provide a way forward for the students concerned.

When students are learning statistics, teachers need to understand that there may be no suitable vocabulary available in their home language. For example, there is no equivalent term for 'probable' in the Tongan language (Latu, 2005). Studies also indicate that the nuances of vocabulary use in the context of word problems, can also pose a challenge (Brown et al., 2009; Sharma et al., 2011). For

example, when asked to define the word 'sample', a number of the Fijian secondary school students based their ideas on their everyday experiences. These included free samples of consumer goods and samples of blood in medical investigations (see Sharma, 2014). The particular challenge here is that the everyday and mathematical/statistical meanings can be more similar than different, and when differences in meaning are subtle, understanding and communicating the distinction is a particular challenge for students and their mathematics teachers (Sharma, 2014). Finally, according to Cummins (1984) English Language learners often develop conversational fluency (basic interpersonal communication skills) within two years of studying a second language. In contrast, developing fluency in cognitive academic language (CALP) can take about seven years, depending on the student's age and level of home language literacy and support. Cummins (1984) claims that failure to understand the distinction between these types of language proficiencies can lead to false assumptions about a student's language ability and students in this position can miss out on important CALP skills.

Challenges and strategies in multilingual educational settings

The research literature describes many language strategies that teachers can use to address some of the linguistic challenges faced when the language medium of instruction is different to the home language(s) of students in an educational setting. The English as a Second Language(ESL) reform movement (National Council of Teachers' of English National Council, 2008) has emphasised that language must be learned simultaneously with content development. However, this situation can present some challenges. Students learning in a language which is not their home language, need to simultaneously learn both ordinary English and discipline-based English and further, to be able to differentiate between these two linguistic types (Halai, 2009; Moschkovich, 2005). Halai's (2009) investigation into mathematical language used in Pakistan provides an explanation of this issue. For understanding the mathematical ideas and concepts, one has to be able to understand the instruction-language. This means that if the instruction-language is foreign to the learner then it becomes a 'double' task - that of learning both the 'foreign' language as well as the mathematics that is being taught, all at the same time. Halai (2009) suggests that this problem can be addressed only by allowing for movement between the languages used in the class.

Later research studies provide further examples of the tension between the use of home and school languages. These examine the use of students' home languages or practices such as code-switching. Clarkson (2007) explains how English Language Learners (ELL) may comprehend target language texts using their first learnt language (L1). He claims that the first language scaffolds semantic processing, while if a learner were to process the input exclusively in a second language/formal language of instruction, then s/he might run into trouble handling syntactically complex sentences. However, at this point, translation is not always beneficial or reliable as it might not reflect the exact meaning. Thus switching between languages can add an extra layer of challenge to language learners, as they may find themselves working between a multitude of registers in both the medium of instruction and their home language (Mady & Garbarti, 2014; Schleppegrell, 2011). In a multilingual setting, students can miss out on learning because they may be spending too much time shifting between informal and formal ways of communicating ideas while trying to understand the instructions and questions.

In New Zealand, Neville-Barton and Barton (2005) have looked at tensions experienced by Chinese Mandarin-speaking students in English-medium schools. Their study focused on difficulties that could be attributed to limited proficiency with the English language. They sought to identify language features that might have created difficulties for students. Two tests were administered, seven weeks apart. In each, one-half of the students sat an English version and the other half sat a Mandarin version of the same test. Each student experienced both versions. There was a noticeable difference in their performances on the two versions of the tests. On average the students were disadvantaged in the English test by 15%. Neville-Barton and Barton (2005) reported that the syntax of mathematics discourse - including prepositions, word order and interpretations of difficulties arising out of the

contexts - created problems for the students. Significantly the researchers also found that the teachers of the students were not aware of the students' misunderstandings.

Research design and data collection methods

Most of the above studies have been done in mathematics contexts, meaning there is a gap in our understanding of how language might be used as a resource in statistics classrooms, where language is even more crucial and students have to read, interpret and communicate findings both verbally and in writing. In this section, a study designed by the author of this article to increase understanding about language use as a resource in a statistics class is described. To conceptualise our study, we drew on design-based research theory (Cobb & McClain, 2004). Design research is a cyclic process with action and critical reflection taking place in turn (Cobb & McClain, 2004; Nilsson, 2013). There are benefits for both teachers and researchers when undertaking a design research partnership: the research plan can be flexible and adaptable to unforeseen effects or constraints (Nilsson, 2013). Further, all participants are equal partners in the research process with no hierarchy existing between researchers and practitioners (Hipkins, 2014; Kieran, Krainer, & Shaughnessy, 2013).

The following inter-related research questions guided our study:

1. What language resources and strategies appear to enhance the statistical understanding of Pasifika students?
2. How do groups of Pasifika students negotiate communication in small group settings?

The study itself involved cycles of three phases: a preparation and design phase, a teaching experiment phase and a retrospective analysis phase. Teachers were involved in the whole research process posing questions, collecting data, drawing conclusions, writing reports and dissemination of findings (see Sharma, 2017).

Phase 1: Preparation and design for the teaching experiment

This phase began with a discussion of research findings on language challenges and language-as-resource pedagogical strategies for ESL learners. The research team (three teachers and a researcher) proposed a sequence of statistical ideas, language skills, knowledge and attitudes that they anticipated students would construct as they participated in teaching and learning activities.

Phase 2: Teaching experiment

The teaching took place as part of regular classroom statistics teaching in three largely Pasifika student dominated Year-12 classes. As part of the learning activities, students carried out investigations of existing datasets using the statistical inquiry cycle method (Ministry of Education, 2007). During the teaching experiment, audio and video recordings of group discussions were made. In addition, copies of students' written work was kept. Each teacher-researcher also kept a logbook of specific events that took place during the data collection period. Logbook entries helped teachers identify and keep track of which strategies seem to work well for students, and which ones were less successful.

Phase 3: Retrospective analysis

The three teachers and researcher performed a retrospective analysis together after each lesson to reflect on and to help refine the lesson plans, while the teaching experiment was in progress. The updated lesson plans were used for teaching future lessons. In addition, the team analysed the whole unit on completion of the teaching experiment cycle.

The next section focuses on data gathered from the three teachers. The section is divided according to key themes arising out of the analysis of teacher reflections. The discussion is supported by the use of the participants' voice through direct quotes. A thematic analysis was used to generate emerging themes (see Braun & Clarke, 2006) with the researcher examining the reflective summaries for topics which were found to re-occur in the data. Themes were then coded in the summaries. Finally, a Skype meeting was held with the teachers to discuss whether the themes were supported, and if any themes needed to be divided or blended.

Findings

As data was analysed and six key themes emerged: integrating statistical language and content, collaborative learning, using home language, using a variety of hands-on activities, using games and matching activities and real-life contexts.

Integrating statistical language and content

All teachers mentioned students' difficulties with reading, speaking and writing in English. This affected their ability to engage in written work. According to Teacher A (TA), this could be due to students not using the English language at home.

> Students don't want to write down…they are struggling to speak, read and write. They remain silent even though they miss key phrases. They speak their own language at home .... even when doing homework they may not speak English. (TA)

In contrast, Teacher C's (TC) reflection suggests that sometimes mathematics teachers might not have the skills to teach the written component of statistics.

> Mathematics teachers find it hard when you got to do scaffolding. We are not natural teachers of writing. It is okay in mathematics and then as maths teacher, we are not good at a particular way of writing and helping with statistics requires a different way of writing. (TC).

Although TC expressed concerns about integrating writing in statistics, it was clear that the teachers were supporting their students in their writing by integrating language strategies and statistics content in their lessons, an important component in statistics lessons and, in particular, statistical projects. All reported that they had to write and draw a lot on the whiteboard. They used class notes so the students could follow what was being discussed. Writing the key terms helped students make sense of the statistical ideas as indicated below;

> They need practice in both reading and writing. I give them time to read what is written on board or in their class notes before I start talking (TC).

All teachers used techniques to make sure all students understood the instructions. Teacher B (TB) gave explanations and instructions in clear and simple language and then asked a student to repeat the explanation so.

> I try to give instructions step-by-step before asking students to do independent, pair, or group work. Then I ask one of the boys to repeat the instructions aloud for the rest of the class to make sure all have understood what is required (TB).

In her whole class sessions, TA slowed down her speaking pace a bit while TC reported modifying the linguistic complexity of his speech by using shorter sentences and re-phrasing questions. As well as modifying speech, TA also wrote notes and questions on a mini whiteboard she used during her small group interactions. This was a useful technique, as TC reflects:

> … the best technique was to focus on writing throughout the PPDAC [problem, plan, data, analysis, conclusion cycle], you can see it in the books (TC).

Both TA and TC also provided a writing frame and cloze activities to help students analyse data and draw conclusions. For example, the following writing frame was provided for writing conclusions about kiwi population data.

> The evidence from my ……suggests that ……..of kiwis is between …….and …….. Approximately …… of kiwi is ……between…… and ……

Students had to complete the statements from their sample results and then write a statement about what they thought might be happening. Some statements were collected on the board so that the class could look at the overall results. TA and TC also mentioned using 'I notice' statements during the analysis phase of the statistical inquiry cycle. The statement below was written on a whiteboard and the students had to copy and complete the statement using a list of statistical terms.

> I notice that the median …… in samples of 30 range from…….. The median weights are similar, this suggests that ……. the median …. is probably in the range……

However, despite assistance, all three teachers found students had difficulty writing appropriate questions related to their statistical work, as TA suggests:

> I found students struggling to write good comparison and relationship questions. I put a summary, comparison and a relationship question on the board and asked them to critique them using 'What makes a good question' criteria. I spent one whole session on posing statistical questions (TA).

Using collaborative learning

Forms of collaborative learning were used by the three teachers. Students were asked to form groups to discuss the ideas and questions they might have relating to the statistical inquiry cycle. Students felt more comfortable in this safe learning environment, according to TC:

> Students are often not eager to share their ideas in front of the whole class. It is not productive to ask the boys to give answers to the entire class. They may not feel confident with their level of English and content and going public may make them more uncomfortable (TC).

This strategy also freed up the teacher to provide more informal explanations of terminology used, as can be seen below:

> "Miss what does Shape refer to?"[one student asked]. One would usually associate the word shape with something that has an external boundary. It was quite helpful to discuss this with students (the fact that we can refer to the box plot and the dot plot) when we talk about the shape of the data. It allowed me as a teacher to elaborate even more in group situations. Words can have different meanings in mathematics and statistics. We spoke about other types of shapes of data distributions. (TA).

However, all teachers mentioned that they had to be careful how they grouped the students. Sometimes the students did not engage in a productive talk in their group, so a variety of grouping methods was used.

> I ask them to form a group of three with two people who do not normally sit at their table. Together, they brainstorm and write down everything they understand about statistical investigations (TB).

Grouping could include students' access to language proficiency:

> I group students of the same home language so they can process information together using their home language. The more proficient English speakers can support them in making sense of the information (TA).

Home Language

In this study, students were supported by teachers and peers to use their home language, English and mathematical/statistical English to develop their understanding. All teachers identified that students' first language(s) already served as a resource for thinking and communication, as students developed their proficiency in the language of instruction and learned statistics.

> In mathematics classes, they sometimes mix language (TC).

Teachers too were already mixing languages while learning was taking place.

> Even teachers sometimes code switch although they don't realise it to gain student attention or to build positive relationships with students. (TC)

However, as TA commented, using a different language was not possible for her.

> They use their home language in groups. Sometimes I am not sure what they are talking about because I don't speak their language (TA)

Further, not all students took advantage of being able to talk more informally in their home language, even when they knew that the initiative was fully supported.

> Students can use their home language in groups. In whole class discussions, they are required to use English. Some of them don't want to use their home language in mathematics classes. (TB)

Using hands-on activities

Providing non-linguistic cues such as visual diagrams, drawings and gestures can make more complex language accessible for all learners. All teachers in the study seemed intuitively aware of this. TA used demonstrations, pictures, gestures and actions to aid understanding. While TA and TB used a hands-on sequencing activity to explore student prior knowledge regarding PPDAC. This activity proved to be extremely useful as TB reflects:

> This activity was a sequencing pre-test to find out what students understood about the PPDAC cycle. They needed to organise the student exemplar into the correct order. It was interesting to note that the students did not need prompts to find where the problem and the data should be placed. They had a difficult time separating out the plan and the analysis. Several of the groups were not sure between the two and this gave me a starting point for where they needed some support……. This task was useful because I identified what students remembered about the PPDAC cycle through discussion. I was able to see which groups of students understood the statistical enquiry cycle because the puzzle was complete. (TB)

Teacher A also reflected on the use of a hands-on activity;

> This activity worked really well in class. In this activity, students had to put a report together according to the PPDAC cycle. They worked in pairs and were all able to start the activity after I gave them a reminder about what PPDAC actually stands for. They discussed with their partner where each piece fitted in the PPDAC puzzle which allowed them to discuss different meanings of certain words.

Using real-life contexts

The teachers in this study were also aware of the use of making connections to the experiences and cultures of Pasifika students.

> When I look back, should have done investigation outside the classroom. Students need to pose questions on something that is relevant to them or their community. Maybe involve the parents as well. (TA)

TB commented on the importance of building contextual knowledge in statistics.

> It is important they understand what population and variables they can make links to. Some of them have never seen a kiwi, they don't understand the context. Halfway I realised that some of them were interpreting kiwi as kiwi people. They related the data to people. Next time I will spend more time on context, maybe show them a video clip about the kiwi population. (TB)

One further theme which emerged from the teacher participants suggested strategies are not so frequently found in the literature concerning working with Year 12 students: Using games and matching activities. TA and TB mentioned using card games to help Pasifika students develop their statistical vocabulary. TB used a fun game called *Forbidden Words* to start or end a lesson**.** The idea of the game was for one player to try and describe a statistical term or phrase without using certain *forbidden words*. The other players have to try and guess the word. For example**,** *Fila* picks out word card - 'standard deviation'. He then has to describe the phrase without using the word meaning - variance, square root and sigma. Other try to guess the word. A game could go like this:

> Fila: It is a summary statistic
>
> Tevita: Mean
>
> Fila: It's a measure of spread
>
> Tevita: Range
>
> Fila: … and it uses a measure of centre
>
> Tevita: standard deviation

To make the game easier teachers could allow students to use one of the forbidden words or have a scoring system based on the number of forbidden words used.

TA used a matching activity to help student's statistical vocabulary. Students were provided with sets of word and description cards and asked to work in pairs and sort statistical terms with their descriptions. For example, the term 'inference' was matched with its description. Once an agreement was reached, they could discuss their answers with another pair of students. Another matching activity involved students matching words and graphs with their descriptions. The activities helped students make connections between different representations.

This final section relates the findings to relevant literature. After outlining some limitations of the study, the paper discusses the implications for practice and research.

Discussion

Supporting English Language Learners in their writing is important in multilingual settings. It is important to have daily routines of writing, reading and speaking about statistics content. All the teachers reported that writing down the key terms helped students see them and connect them to the spoken word. This use of writing on the board to aid the language learning and comprehension of the

students concurs with the findings of Sharma, Doyle, Shandil, and Talakia'atu, (2011) and Winsor (2007). Sharma et al (2011) found that writing words/vocabulary on the board re-enforced learning for Pasifika students. TC's concerns about writing skills of mathematics and statistics align with Meaney and Kirsten (2009) who claim that mathematical texts use language and diagrams in ways slightly different from those used in other subjects. Part of the learning for students and teachers may involve learning the common ways of presenting written materials including diagrams such as graphs.

Year-12 students in this study had difficulty posing good statistical questions from data. TA's written modelling helped students realise statistical questions can be classified into three categories. Hoffert (2009) used a similar strategy. She gave each student a question on a card with magnets on the back and had the class sort these questions into three categories without any specific explanations. Students who did not speak the same language tried to communicate with one another while sorting. Hoffert (2009) claims that since they developed their understanding in a group activity they remembered the three types of questions.

What may seem normal speaking pace to a native speaker of any language may seem too fast for comprehension to a language learner. TC reported modifying the linguistic complexity of his speech at times by using shorter sentences. This finding concurs with the claim made by Hoffert (2009), who stated that when teaching ELLs teachers need to use short, simple sentences and avoid using slang/colloquialisms. For example, instead of saying 'goes into' use 'divided into'. Collaborative work allowed the students to collaborate in their learning and ties in with the work of Brown, Cady and Taylor (2009) and Winsor (2007) who explain that when language learners are able to work alongside a partner, they are given the opportunity for interaction and support, enhancing their learning. Goldenberg (2008) reported that collaboration can afford language learners the chance to ask questions and make mistakes in a safe setting, where they can receive direct and immediate feedback. This is especially true when language learners are partnered with a peer who has a higher degree of language proficiency in the language which is the medium of instruction.

A number of researchers in mathematics education have identified that students' first language(s) can serve as a resource for thinking and communication as students simultaneously learn and develop proficiency in the language of instruction and learn mathematics. In this study, students were supported by teachers and peers to use their home language, English and mathematical/statistical English to discuss and develop their understanding of statistics. The home language might have served as an important scaffold for the accomplishment of the data-driven statistical task in English. However, these findings show that students need time to feel confident enough about using their home language in a group setting. The sense of stigma, as well as a lack of mathematical reasoning in English, has to be overcome.

While research shows that many teachers believe using home language is detrimental to learning (Mady & Garbarti, 2014; Planas & Setati-Phakeng, 2014; Winsor, 2007), this was not the case for the three participants who could see the educational value of learners being able to using their home language(s) in the classroom. What did prove difficult was the changed role of the teacher who cannot understand the home language.

Providing non-linguistic cues such as visual diagrams, drawings and gestures can make more complex language accessible for all learners and the teachers seemed to be intuitively aware of this. The teachers used strategies that supported students visually and were helpful in scaffolding students who did not have the language skills to match their statistical ability. The findings are consistent with the studies done by Nguyen and Cortes (2013) and Lee, Lee and Amaro-Jiménez (2011). Nguyen and Cortes claim that visual aids, such as diagrams and posters can enable students who may not have the ability to pose their questions in English, or who do not have the confidence to approach their teachers to find answers. According to Lee, Lee and Amaro-Jiménez (2011) using physical objects can work to contextualize mathematics, which is important because academic mathematical language is frequently decontextualised, which is challenging for English Language Learners.

Card games can be a fun way of helping students to link verbal, symbolic, graphic or story representations of the same values and concepts. TA and TB mentioned using card games to help Pasifika students develop their statistical vocabulary. Rubenstein and Thompson (2002) write that hands-on activities such as games, sorting and matching activities and puzzles, not only pique interest but also reinforce statistical topics. They add that, for a richer learning experience, students can be invited to create their own set of equivalent cards for new terms and symbols they have learnt.

The teachers in this study were aware of making connections to the experiences and cultures of Pasifika students. Teacher A's response suggests the importance of learning activities that incorporate students' language, culture and community rather than reflect beliefs that these characteristics are limitations. According to Hoffert (2009), using the contexts provided by English Language Learners can help provide opportunities for students to use contexts relevant to their communities during statistical investigations. This does not only mean that English Language Learners will understand the contexts used, but also will indicate to them that their cultures and the resources they bring with them are valid and valued (Planas & Civil, 2013). The emphasis on community within the cultures of many English Language Learners could be developed into a resource-rich classroom learning community, where real-life contexts for statistics applications could naturally and readily emerge.

Students, when carrying out statistical investigations focused on real-life contexts, can often get side-tracked by irrelevant details while ignoring relevant information. For example, some students in TB's class interpreted kiwi birds as kiwi people. The findings concur with the findings of Brown et al. (2009), Parvanehnezhad and Clarkson (2008) and Sharma (2014). Brown et a argue that when students are faced with contexts that are unfamiliar, it can hinder their ability to understand what is being asked of them.

Limitations

The number of participants in the study is small, thus there are limitations on the generalisability of results. It was not possible to isolate whether language strategies used were because of age, gender or prior experience. A study with more participants might well achieve these types of results which would then have implications for constructing support to change teacher practices. Secondly, it would be valuable to know what the students thought about the strategies used by the teachers. Future interviews with students will help explore their thinking regarding the language use of teachers in the statistics lessons to support student learning. Finally, this study did not intentionally look at ways in which features of Pasifika languages can help re-enforce concepts of statistics. For example, Bannon (2007) noted that in Malay the expression for the mean is 'mama rata', which translates roughly as 'same level'. Hence the Malay language invokes the 'levelling' conceptual interpretation of the mean. This idea could be the focus of future research.

Implications for practice and research

Our study shows that dealing with multiple languages in multilingual classrooms is challenging for teachers. Several, albeit small, studies in New Zealand have indicated that, despite the existence of the Ministry of Education documents specific to English Language Learners, teachers have limited awareness of issues relating to bilingualism and strategies to support language learners in the classroom. The teachers in the present study demonstrated a range of specific strategies consistent with research-based effective language learning practice. Whether this was by virtue of prior learning in teacher education or professional development, or by experience in the collaborative setting cannot be determined here, but this could be an area for future investigation.

Due to the internationalisation and globalisation of mathematics education, there has been a growing interest in language and cultural issues in multilingual settings. Hence, this research will be of interest to the international community because it involves looking at issues that are relevant to schools in English speaking nations worldwide. Teachers need to re-evaluate their teaching methods,

especially if part of their population is learning English as a second language. Like proponents of the language-as-resource perspective, this paper argues that equity and academic excellence will not be attained until learners' home language is used as a resource in multilingual classrooms. This view has implications for our Education policy (Ministry of Education, 2007) which states that all learners need to feel secure in their identities, languages and cultures and contribute fully to Aotearoa New Zealand's social and cultural wellbeing.

Views about statistics teaching and learning have shifted considerably in New Zealand and internationally over recent decades, and it is important for teachers to be kept informed about changes in the ways that statistical processes and language are being emphasised. It would be useful if schools were to highlight the importance of language in mathematics and other learning areas, in their interactions with teachers and families. Not only would this help with mathematics but the role of language and culture will expand to other curriculum subjects and wider society. Furthermore, teachers could use parents and family as a resource to contribute to a student's learning. Teachers could keep parents informed of the topics under study perhaps by sending home learning grids. This would enable parents to share their own mathematical knowledge through their first language and provide the students ideas about how mathematics is situated within their wider experiences. It is hoped that the findings reported in this paper will generate more interest in language challenges and strategies in statistics education and collaborative research, where teachers are regarded as key stakeholders in all aspects of the research process. Teachers, curriculum developers and researchers need to continue to work together to find ways to help all students develop statistical literacy.

To close, Averill et al. (2009) share a whakatauaki;

> *Ahakoa he iti, he pounamu.*
>
> Be it ever so small, it is as precious as the greenstone.

This is an important reminder that despite how small the element of linguistically and culturally responsive pedagogy, the inclusion of it is precious.

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