

TEACHING AND LEARNING STATISTICS IN MULTILINGUAL CLASSROOMS: A COLLABORATIVE STUDY

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The purpose of this collaborative study was to explore what language practices appear to enhance the statistical understanding of Year-12 multilingual students. Data was collected from audio recordings of teacher reflections while students were carrying out an investigation of existing data sets. The teachers in the 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 by experience in the collaborative setting cannot be determined here, but this could be an area for future investigation. The 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.

INTRODUCTION

The issues of mathematics teaching and learning in multilingual and multicultural contexts are strongly located in the dynamics of a highly globalized society of the 21st century. Classrooms deemed to be multicultural are places where learners have different linguistic and cultural backgrounds, where they may speak one language at home and another language at school, where teachers and students may not share a common language or cultural background, and where some or all of the students are learning the language of instruction as a second language (Dockrell et al. 2022; Lesser & Winsor, 2009).

New trends in multilingual education have provided opportunities to change traditional approaches to teaching and to explore the potential advantages of translanguaging. Translanguaging is a dynamic process whereby multilingual language users mediate complex social and cognitive activities through strategic and flexible employment of the multiple communicative resources they have (García & Leiva, 2014). These resources include gestures, objects, everyday experiences, home language, and a mixing of languages and mathematical representations (Moschkovich, 2018). The paper begins by reviewing the literature that informed our collaborative study. The next section describes the design-based research conducted at one school.

Section three presents the findings and links to relevant literature. The final section offers suggestions for teaching and further inquiry.

RESEARCH 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 of instruction is different to the home language(s) of students in an educational setting. The ESL (English as a Second Language) reform movement has emphasised that language must be learned simultaneously with content development. However, this situation can present some challenges because students learning in a language that is not their home language need to simultaneously learn, for example, both ordinary English and discipline-based English, and, further, to be able to differentiate between these two linguistic types (Halai, 2009; Moschkovich, 2018). Halai's (2009) investigation into mathematical language use in Pakistan provided an explanation of this issue. The study revealed that in order to understand the mathematical ideas and concepts, one has to be able to understand the instruction language, which means, if the instruction-language is foreign to the learner, then it becomes a "double" task of learning both the "foreign" language as well as the mathematics that is being taught, all at the same time. She suggests that this problem can be addressed only by allowing the movement between the languages used in the class. The ideas within statistics can be particularly challenging because of the way they are intertwined with everyday language (Lesser & Winsor, 2009) and cultural values, and so teachers need to be sensitive to the implications of language and cultural differences (Sharma, 2014). For example, students in Sharma's (2014) study drew upon their religious beliefs in thinking about everyday probability scenarios. Moreover, the concepts of statistics do not develop incidentally or through

maturation; rather, students need to be provided with planned learning experiences that include activities and simulations, not just abstractions.

Later research studies provide further examples of the tension between home and school languages through examining the use of students' home languages, or practices such as code-switching. 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 (Mandy & Garbarti, 2014; Schleppegrell, 2011). In a multilingual setting, students can miss out on learning because they may be spending time shifting between informal and formal ways of communicating ideas while trying to understand the instructions and questions.

RESEARCH DESIGN AND DATA COLLECTION METHODS

To conceptualise our larger 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). There are benefits for both teachers and researchers when undertaking a design research partnership: the research plan can be flexible and adapt to unforeseen effects or constraints. All participants are equal partners in the research process with no hierarchy existing between researchers and practitioners (Kieran et al., 2013). This paper is focused solely on teachers' reflections and not on the larger study.

Our study 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 disseminating findings (see Sharma, 2017). 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 data sets using the statistical inquiry cycle method. From the perspectives of teachers who participated in design research to enhance the statistical learning of multilingual Pacifica students, this paper focuses on the following research question: What language resources and strategies appear to enhance students' statistical understanding?

Data was collected from audio recordings of teacher reflections while students were carrying out an investigation of existing data sets. The researcher examined the reflective summaries for strategies that were re-occurring in the data. These themes were then coded in the summaries, and 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 AND DISCUSSION

This section focuses on data from the three teachers. Discussion is supported by participants' voice through direct quotes.

Integrating Statistical Language and Content

All three teachers mentioned students' difficulties with reading, speaking, and writing in English. This affected students' abilities to engage with class work. Teacher C's reflection suggests that sometimes mathematics teachers might not have the skills to teach written component of statistics.

It comes across a range of disciplines that writing is a problem for most of our students. It comes out in assessments. Students leave sections blank. They need to develop writing skills. 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.

Although Teacher C expressed concerns about integrating writing in statistics, the teachers supported their students in writing by integrating language strategies and statistics content in their lessons, which is an important component in statistics lessons, particularly for statistical projects. The teachers all reported that for their statistics sessions, they had to write and draw a lot on the whiteboard and use class notes so the students could follow what was being discussed. Writing key terms helped students to see them and connect them to the spoken word. Teacher C also checked to make sure that students could read and understand what was on the board before proceeding. Teacher B gave explanations and instructions in clear and simple language and made sure students understood the instructions.

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.

What may seem normal speaking pace to a native speaker of any language may seem too fast for comprehension to a language learner. The addition of complex terms and concepts in statistics can make learning even more difficult. In her whole class sessions, Teacher A slowed her speaking pace. At times, Teacher C reported modifying the linguistic complexity of his speech by using shorter sentences and re-phrasing questions.

In addition to modifying her speech, Teacher A wrote notes and questions on a mini whiteboard she used during small group interactions. Teacher C reflected: *“The best technique was to focus on writing throughout out the PPDAC cycle, you can see it in the books.”*

Year-12 students in this study had difficulty posing good statistical question from kiwi data. All three teachers found students struggling to write appropriate comparison and relationship questions. Teacher A reflected:

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.

Teacher A indicated that this modelling helped students to realise that statistical questions can be classified into three categories.

All three teachers reported that writing key terms helped students to see them and connect them to the spoken word. This use of board writing to aid students’ language learning and comprehension concurs with the findings of Sharma et al. (2011) and Winsor (2007). Sharma et al. (2011) found that writing words/vocabulary on the board re-enforced learning for Pasifika students.

Collaborative Learning

Collaborative learning was used by the three teachers. For most statistics sessions, the students were asked to form groups to discuss the ideas and questions they might have relating to the statistical inquiry cycle. Group work allowed the students to ask questions and get feedback in a safe learning environment, as pointed out by Teacher C.

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.

All three teachers mentioned that they have to be careful how they group students. They found that sometimes the boys did not engage in productive talk, so they had to use different grouping methods. Teacher A indicated, *“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.”*

Collaborative work allowed the students to collaborate in their learning and ties in with the work of Brown et al. (2009) and Schleppegrell (2011), who explain that when language learners work alongside a partner, they are given the opportunity for interaction and support to enhance their learning. Schleppegrell (2011) reported that collaboration can afford language learners the chance to ask questions and make mistakes in a safe setting in which 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 that is the medium of instruction.

Home Language

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 about statistics as reflected by Teacher B: *“Students can use their home language in groups. On whole class discussions they are required to use English. Some of them don’t want to use their home language in mathematics class.”*

The teachers 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 statistics. As observed by Teacher C, *“They use home language outside the classroom. In*

mathematics classes they sometimes mix language. Even teachers sometimes code switch although they don't realise it to gain student attention or to build positive relationships with students."

Research shows that many teachers believe using home language is detrimental to learning (Mandy & Garbarti, 2014; Planas & Setati-Phakeng, 2014) because it can interfere in the learning of English language. However, this was not the case for the three participants, who could see the educational value of learners using their home language(s) in the classroom. Teachers' use and perceptions of the value of a particular language in different settings varied. For example, while students used home language in group settings, they were required to communicate in English in whole-class discussions. The findings concur with Planas and Setati-Phakeng (2014), who reported that while students used their home language in small group settings, they did not do this during whole-class discussions.

Using Real-Life Contexts

The teachers in this study were aware of the importance of making connections to the experiences and cultures of Pasifika students as reflected by Teacher A.

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. May be involve the parents as well. Benefit the students experiences. They need to understand the whole process of the statistical enquiry cycle.

Teacher B also 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. Half way 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, may be show them a video clip about kiwi population.

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

Using Games and Matching Activities

Students love games, and playing games in the classroom can improve students' attitudes and motivation and encourage students at all levels to participate. Card games can be a fun way of helping students to link different representations (verbal, symbolic, graphic) and concepts in statistics. Teacher A and Teacher B mentioned using card games to help students develop their statistical vocabulary. For example, Teacher B used a fun game called *Forbidden Words* to start or end lessons.

The idea of the game was for one player to try to describe a statistical term or phrase without using forbidden words. The other players have to try to guess the word. For example, Fila picks out word card "standard deviation." He has to describe the concept without using the words mean, variance, square root, and sigma. To make the game easier, teachers could allow students to use one of the forbidden words or to have a scoring system based on the number of forbidden words used.

Providing non-linguistic cues such as visual diagrams, drawings, and gestures can make 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 studies done by Nguyen and Cortes (2013). These authors 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.

Teacher A and Teacher B mentioned using card games to help Pasifika students develop their statistical vocabulary. Chow et al. (2011) claim that games are very effective alternative activities that provide students with a learning environment that is fun and educational. Additionally, games help in creating opportunities for independent learning and overcoming challenges for English language learners. Children who are reluctant to participate in mathematical activities because of language barriers will often join in a game. As a result, they gain access to mathematical learning as well as engage in structured social interaction.

IMPLICATIONS FOR PRACTICE AND RESEARCH

Our study shows that dealing with multiple languages in multilingual classrooms is challenging for teachers. For example, when a teacher does not speak the language of every English language learner in his or her class, he or she may not be able to understand student responses in students' home languages. Teachers need to be familiar with a range of strategies such as collaborative learning and use of hands-on activities to bridge the language barriers so that the situation does not limit the ability of a learner to communicate statistically.

While several, albeit small studies in New Zealand have indicated that despite the existence of the New Zealand Ministry of Education (2008) documents specific to English language learners, teachers have limited awareness of issues relating to bilingualism and strategies to support language learners in the classroom. However, 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.

This research can benefit teacher education institutions. Understanding challenges and some of the opportunities teachers face in the classroom when teaching learners with a range of languages and language proficiencies can enable teacher educators to better equip student teachers and teachers to work in multilingual and multicultural classrooms.

Due to the internationalization and globalization 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 for schools in English speaking nations worldwide

Like proponents of the language-as-resource perspective, we argue 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 (New Zealand Ministry of Education, 2008), 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.

The reported strategies of the teachers in this article appear to fall into the 'Language-as-a-resource' approach (Planas & Setati-Phakeng, 2014). By adopting strategies such as collaborative learning, writing, adjusting speech, and code-switching, teachers were encouraging their students to use whatever linguistic resources they had to understand and share ideas about statistics.

Although this paper only discussed data sought from the teachers, it would be valuable to know what the students thought about 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.

Policy makers need to support research focused on multisite ethnographic studies of second-language mathematics classrooms. Such studies are necessary to develop the kind of cumulative findings called for by Barwell (2020) because they can be used to compare and contrast mathematics learning processes and outcomes across a range of different settings.

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.

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