TEACHING & LEARNING
RESEARCH INITIATIVE
NĀU I WHATU TE KĀKAHU, HE TĀNIKO TAKU

PO Box 3237
Wellington, New Zealand
Email: tlri@nzcer.org.nz
Website: www.tlri.org.nz

Tamsin Meaney, Uenuku Fairhall, and Tony Trinick

Te reo tātaitai: developing rich mathematical language in Māori immersion classrooms

Analysis of the Māori medium numeracy project (Te Poutama Tau) student data found that language proficiency was a significant factor in student achievement in the higher stages of the number framework (Christensen, 2003). In kura kaupapa Māori, students often have te reo Māori as a second language. Consequently, there is a need to understand more about how to support students learning mathematical content at the same time that they are learning te reo Māori and, in particular, the mathematics register, te reo tātaitai. This situation is complicated by the newness of this register in te reo Māori (see Christensen, 2003; Meaney, Fairhall, & Trinick, 2006). The effect of language on mathematics learning has been recognised for sometime (Ellerton & Clarkson, 1996), but little research has been carried out on how students acquire the mathematics register.

During 2005 and 2006, this Teaching and Learning Research Initiative (TLRI) project gathered information on the acquisition of the mathematics register by documenting and evaluating the scaffolding and modelling of student's mathematical language by the teachers in a kura kaupapa Māori. It involved a partnership between seven teachers of mathematics at Te Kura Kaupapa Māori o te Koutu and three researchers. The teachers were also participating in Te Poutama Tau and felt that this research would complement that project. Having all the teachers involved in this project meant that the results are seen as coherent and of use in discussions about the mathematics programme.

The final stage of the research investigated how this knowledge affected the teaching practice of those involved and this enabled an appropriate evaluation of the research for its practical value to be undertaken. Better understanding of how the mathematics register is acquired is likely to be of benefit not just to kura kaupapa Māori teachers and their students, but also to others considering language issues in other content areas.

Research aim and questions

The aim of the research was to develop a kura-wide understanding of how mathematical language is modelled and scaffolded, and how these modelling and scaffolding strategies change as students progressed through the kura. As a consequence, the research questions were:

- What are the most effective ways for teachers to model and scaffold mathematical language for students?
- Are these modelling and scaffolding strategies different for different ages of students?
- Does awareness of different modelling and scaffolding strategies have an effect on the ways that teachers approach the development of students' mathematical language?

Research design and methodology

The research methodology used an ethnographic research tradition (Fetterman, 1993). It combined kaupapa Māori research principles (Christensen, 2003) with complementary accounts methodology (Clarke, 2001) and participatory research (Reason, 1994). Data were primarily collected through videotaping each of the seven teacher's mathematics lessons in both 2005 and 2006. The classroom interactions were transcribed and the teachers then watched them with a researcher. The joint analysis involved identifying the modelling and scaffolding strategies that the teachers used in the classroom. These were categorised using the stages in the Mathematics Register Acquisition model of noticing, intake, integration, and output (Meaney, 2006). Meetings were held regularly to discuss the results from the analysis and realign the project to meet the kura's changing needs. Consequently, notes from these meetings also became further data that were used in the analysis. Teachers were interviewed and surveyed in August 2006 about their perceptions of being involved in the project. Their comments, plus reflection notes from one teacher, were the data that contributed to responding to the final research question.

Strategies for each stage

Below is a summary of some of the strategies used in relation to each stage of the Mathematics Register Acquisition model at the kura.

Noticing

Noticing strategies were used by teachers to make students aware of new vocabulary or grammatical expressions of the mathematics register. At this stage of learning, most of the responsibility for highlighting new language is with the teacher. Students need to recognise that a new term or expression is important before they can begin to learn it.

Strategies identified with the noticing stage included:

- using linguistic markers to highlight what is to come
- using intonation to emphasise a correct term after students use an incorrect one
- repeating new terms and expressions several times in appropriate places
- using "fill-in-the-blank" sentences.

Intake

Intake strategies are where students are expected to use the language either through listening, speaking, reading, or writing, but not fluently. At this stage, most of the learning revolves around "doing mathematics". What is emphasised is not the language, but the solving of problems, of which being able to use the new meanings or terms or expressions is an implicit part.

Strategies associated with the intake stage included:

- giving the first syllable of a term so that students are reminded of the term and then say the complete term
- asking students for names, definitions, or explanations of terms
- asking students for examples of a term
- having students draw their own diagrams or use materials to show a particular term.

Integration

Integration strategies are where the students would be using new terms and expressions fairly consistently. However, it is likely that if the students are struggling with the mathematics concepts, then they could revert to more familiar terms. The teacher's role becomes one of supporting students to continue to use the new language even when they are expecting the mathematics to be difficult. This stage is important as it emphasises for students the value of being able to use appropriate language to discuss and describe what they are doing.

Strategies associated with the integration stage included:

- using commands and linguistic markers to highlight for listeners that they need to pay extra attention to what they are hearing and doing
- asking a student to repeat a good response
- if a slight correction is needed, the teacher can model doing the action so that the student self-corrects their own response
- having students write a summary of, or record as a diagram, what they have learnt.

Output

By the final stage in the model, the students use their mathematical language confidently, even in the most challenging situations. The teacher's role is reduced to providing contexts in which the aspects of the mathematics register will naturally occur. Students' fluent use of the mathematics register enables them to use that language as a resource for their mathematics learning.

Strategies associated with the output stage included:

- providing opportunities for students to use their acquired aspects of the mathematics register between themselves and with the teacher
- providing an environment in which the students can query the language use of the teacher.

Teachers in this study agreed to trial strategies that they had not used previously. The choice of strategies highlighted which ones the teachers felt were would be effective. On the whole, these strategies tended to be those ones that supported students gaining a metacognitive awareness about their learning of the mathematics register. They were also strategies that tended to encourage students to move between modes of expression such as speaking to writing.

Scaffolding and modelling of te reo tātaitai

As a maximum of five lessons were videotaped for each teacher, it was not possible to identify the strategies that were the most successful in supporting students' use of new aspects of the mathematics register. That would have required a longitudinal study, such as the one undertaken by Gibbons (1998), where examples of both classroom talk and students' writing were collected and analysed together. What is clear from our data is that there was never one strategy that characterised how a teacher scaffolded language learning when they believed their students to be operating at a particular stage on the Mathematics Register Acquisition model. All of the teachers used more than one strategy when operating at a particular stage. Thus, in considering issues of effectiveness, there is also a need to consider the combination of strategies that a teacher used at each of the various stages.

When considered in isolation, some strategies employed by the teachers at the various stages could be considered less effective than others. For example, having students repeat an answer, after the teacher has gone through an explanation to reach it, is perhaps not going to highlight for students new aspects of the mathematics register very effectively. However, when this is one strategy of many, all designed to support students to become aware of these new aspects, then it could be seen as having more value. Combining a range of strategies, therefore, seems to be part of what makes effective support for students who are operating at the different stages.

The reasons for the provision of various types of strategies are two-fold. The first is that the teachers are aware that different students will respond better to some scaffolding and modelling strategies than to others. Thus, it is important to provide a range of scaffolding and modelling strategies to match these different students' needs. The second reason may also be that, if strategies were used from two different stages, the teacher believed that there were students in the class who were working at different stages of the acquisition model.

The effect of student age on modelling and scaffolding strategies

From the videotape evidence, there was a sense of the progression for acquiring aspects of the mathematics register across the kura. This progression is quite clearly related to the year level of students. However, the relationship between the strategies that teachers used and the year level that they taught was much less clear. Factors such as the topic of the lesson and how new the material was to students did influence the teachers' choice of strategies. On the whole, most strategies tended to be independent of age.

And yet, it was clear that the year level that students were in did have an effect on the aspects of the mathematics register that were taught. There were many aspects of the mathematics register that students needed to acquire, for example, in regard to ideas about triangles. These started, for example, with being able to recognise it as a shape and being able to name it as a triangle. From there, the teachers believed that students needed to be able to recognise and to talk about different features, including angles.

The teachers' discussion about what aspects of the mathematical register students needed to know when they started in a year level and what would be taught was ongoing. The teachers found this discussion useful as it gave them a sense of how ideas and the accompanying language demands developed. Christensen (2003) stated that "[i]f students are introduced to the specialised vocabulary relevant to their level, they will experience less difficulty when further terms are added as they move to higher levels" (p. 35). Discussions contribute to the kura having a cohesive understanding of the mathematics register that students would be expected to know and learn at each year level. The teachers suggested that a word bank be developed so that the word usage across the kura would be consistent.

Effect of the research on teachers' practice

The comments made by the teachers showed that they felt that being part of the project had had a positive impact on their teaching. Traditionally, professional development has focused on either teachers' pedagogical knowledge or their mathematical content knowledge (White, Mitchelmore, Branca, & Maxon, 2004). This research project could be considered as doing neither and, at the same time, doing both. This is because it was not specifically about mathematics or

about mathematics teaching. Instead, it was designed so that teachers could become better aware of how they supported their students to acquire the mathematics register. This awareness led to teachers making changes to their practice so that students could improve their learning of mathematical terms and expressions. For example, one teacher became more conscious of providing explicit teaching of new vocabulary. In 2006, he consistently put a list of vocabulary up on the board to accompany each new unit. Previously he had done this on an ad hoc basis.

The research process was challenging for some of the teachers, but most found that it supported their reflection process. Although the teachers, at the beginning, found being videotaped daunting, it did begin the process of reflection. Consequently, the teachers found this part of the research process rewarding. The teachers also offered a number of suggestions for how the videotaping and analysis could be improved so that the findings would be more valuable to them. Having the project continue for a second year meant that the teachers were able to move beyond the concerns of the first year and choose to videotape lessons that they wanted to learn something from.

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The full reports of all TLRI projects are published on the TLRI website (www.tlri.org.nz).

Lead authors and researchers

Tamsin Meaney has worked as a teacher in many situations which have made her consider the relationship between language and mathematics learning. She currently lectures in the Bachelor of Teaching programme at the University of Otago College of Education.

Tony Trinick has many years of experience in Māori medium primary, secondary, and tertiary mathematics education, and preservice teacher and teacher professional development. He is currently Associate Dean Māori at The University of Auckland's Faculty of Education.

Uenuku Fairhall (Te Arawa: Ngāti Rangiwewehi, Waitaha, and Ngāi Te Rangi: Ngāti Hē) is the principal of Kura Kaupapa Māori o te Koutu. He is one of the most experienced teachers of mathematics in te reo Māori in New Zealand.