

Changing Practices in Indigenous Communities

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Educating teachers in Indigenous communities to use collaborative mathematics is a challenge. This is particularly the case in developing countries such as Papua New Guinea. First there are the issues around the perception of authority and questioning in school. Second, there is the issue of class atmosphere and teacher pedagogical knowledge. Third is the issue of meeting different needs in large under-resourced classes. Finally there is the issue of teacher professional learning. This paper discusses one attempt that has led to an increased awareness and use of the role of questioning in the classroom. It points out some of the aspects of teacher development and what seemed to be contributing to change.

Questioning as an Issue in Indigenous Communities

In a previous study of early career teachers learning to undertake substantive communication in their NSW rural Australian classrooms, the Indigenous students were a minority. However, it was found that participating in their own professional learning with considerable substantive communication was influential in changing their teaching practices. Deliberate preparation of lessons that incorporated planning guided inquiry and questions was also effective in changing these teachers' approaches to teaching (Owens, 2005a, 2005b). However, Sullivan, Jorgenson, Lerman and Boaler (2013) published a paper discussed teacher professional learning using principles of complex learning, concentrating on "the nature of the group work, use of home language within groups, quality interactions between teachers and students, valuing a variety of representations, defined roles, and teacher as facilitator" (p. 177). The teachers were working in Aboriginal communities in the Kimberley, Western Australia, and one of the complexities related to questioning. Culturally it was considered that questions were asked if you genuinely wanted to know about something you did not already know, that the relationship of the questioner and respondent could influence the asking of questions and the nature of questions and that one should also not shame someone especially an older person by questioning. Culturally, if some knowledge was needed to solve a problem, the knowledge itself does not need to be shared but the problem was solved by a group who had the various knowledges working on the problem (Thornton & Watson-Verran, 1996). This was the perception of the teachers and researchers in the Kimberley project. These researchers set about to claim that an alternative to questioning, namely demonstration was an adequate means of development where students supposedly learnt in their home culture by watching and imitating. Similar comments have been made of Papua New Guinea Indigenous communities in which learning by observing and participating where possible were highly valued. However, oratory was also highly valued. Classrooms are often observed in which teacher talk is dominant, children copy from the board after trying some repetitive activity, and learning tables is a common rote activity not related to reality.

However, it seems that efficiency of learning would require some form of interaction between teacher and learner. It was noted in a village serviced by one of the schools in our current study that one Elder by pointing and talking was able to explain to another why his weaving might need correcting to get the desired pattern. Elders were also able and willing

2015. In M. Marshman, V. Geiger, & A. Bennison (Eds.). *Mathematics education in the margins (Proceedings of the 38th annual conference of the Mathematics Education Research Group of Australasia) on-line*. Sunshine Coast: MERGA.

to describe what they were doing when carrying out mathematical activities in cultural practices. They were also willing to involve younger men in discussing their procedures and acknowledging their contributions (Owens, 2010, 2015).

In a recent anecdote with one of my mature-aged Aboriginal students in NSW, I was explaining how PNG Indigenous people seemed to have a mental idea of ratio rather than an exact calculated ratio (Owens, 2015). She chirped into my sentence. “That’s what my dad did. He could have a really good idea about number sizes and distances and things but he didn’t explain it.” Does a lack of questions in fact mean that observations are not accompanied by words which would assist further processing and knowing of strategies of thinking even if they are mentally imagined rather than precise words? This same student is always challenging me with questions. “Why do we need that? What is that related to? Where does it fit in?” She typically thinks before responding in our conversations but she does ask questions of the teacher with whom she has a good relationship. She explains to me her Aboriginal ways of responding. Thus it seems that there is a debate about questioning and its role in Indigenous classrooms in which inquiry methods are used to encourage conceptual development and mathematical thinking.

Large Classes, Limited Resources, and English as a Further Language

One of the reasons for the prevalence of teacher talk and demonstration in PNG is the large class sizes. Classes generally have 45 children or more. There is limited secure space for teaching equipment and difficulty in getting materials from the nearest road. Where there are good facilities with road access and parental incomes, it is not unusual for equipment to last only a short time in good order. Coupled with lack of space and equipment and no access to photocopying in most cases, teachers resort at best to demonstrating concepts with their self-developed or collected equipment. A snippet will indicate some of the teaching limitations in such a school. The syllabus¹ provided one outcome for measurement that would seem to be culturally appropriate since lengths are used in PNG cultural negotiations about areas, weights, and volumes (Owens & Kaleva, 2008a, 2008b). The outcome combines length, weight and volume and measuring in units. Using this outcome, the teacher was teaching about weight. She had two similar soft drink bottles filled with sand to different levels. She held them horizontally in her hands and asked the children which was the heavier, several children were asked to answer. Children were then asked how they measure and the children gave the example of steps. “Good.” One child stepped along the wall as the children counted. The words *unit* or *attribute* were not mentioned. The teacher was unaware that volume, weight, and length each had their own type of unit. While she knew that weight could be felt by holding in both hands and comparing, the children were not doing this – they were relying on the visual volume of sand to make the decision (which was not very easy to see in the horizontal position of the bottles). Despite the syllabus revision with considerably more detail, teacher education also needs to be extended.

Limited Teacher Professional Learning

Teachers may have had three lots of two-week training with self-instruction units to continue their learning. The content knowledge of mathematics and the pedagogical knowledge about teaching mathematics is very limited in the self-instruction units. They

¹ A new draft syllabus was available in January 2015.

are supposed to be supervised by a more experienced teacher in their school. There are trainers for a cluster of schools, most of whom have had a two-year, post-grade 10 or 12 teacher education in primary education with little coverage of early childhood education. While all should have had sufficient English for this higher level of education, much of it was taught in Tok Pisin and the teachers had little to read and rarely spoke English in everyday life. This made learning about mathematical concepts expressed in English relatively difficult to grasp if your main source of learning was reading.

One aspect of the research project related to the effectiveness of a workshop that tried to cover early mathematical learning in a cultural context. For this part of the research, the research question was focussed on improving teachers' planning to reduce lecturing the material to be learnt and to involve children actively in their learning. Teachers were encouraged to make connections to their social contexts and past experiences including language.

The Study

This paper reports on the development and change process based on three particular teacher professional learning workshop in the second phase of a three-year project to improve mathematics teaching in PNG elementary schools using local languages and cultural practices. With permission, the workshops were videotaped in part and field notes were made during the workshops. In addition, artefacts of the participants' work during the workshop were photographed. Participants were asked to write an evaluation of how the principles that were being promoted influenced their thinking through the workshop (Owens, Bino, Edmonds-Wathen, & Sakopa, 2014). This multi-case study was participatory in that the researchers or project team colleagues were present in each of the workshops. However, elementary school trainers were also involved in the teaching of the workshops.

The data was interrogated in a number of ways, one of which was to respond to our own 'aha' moments while participating. In one instance, it was that of questioning. Here we were encouraging good questions such as open-ended inquiry questions, good questioning techniques such as group discussion of responses rather than IRA (initiate-response-evaluate) methods (NSW Quality Teaching Practices guidelines), and yet the team members were keenly aware of the literature on questioning in Indigenous education in Australia. However, questioning was only part of the focus. We were also focussing on teachers identifying the key ideas about the concepts and how to actively involve children in whole class and small group activities. There was an issue of overcoming the hegemony of current teaching practices. The analysis of the implementation of the principles indicated several key aspects of the professional learning workshops that made a difference in terms of using questions in teaching through inquiry for more substantial communication and learning.

Results

The following aspects of the professional learning workshops had been highlighted by participants as significant in the way they considered teaching mathematics. In addition, we were able to observe teachers almost struggling with a new expectation of their teaching but with pride in achievement. The significant points cluster under several themes: experiencing the new idea, having a go at the new approach, having a sense of

connectedness, gaining new knowledge about children learning mathematics, and identifying their own cultural practices or ways of teaching, both practical and theoretical.

Experiencing the New Ideas

Open-ended questions. From the very first trial workshop, we have had teachers make a note that the first activity really changed their thinking. As a way of getting to know the teachers and for them to know each other, we asked each to write in large letters their first name on a piece of paper and to put four numbers, one in each corner, that were important to them. This sat on the floor or desk as their name tag. The workshop facilitator provided an example. Then they were to explain to a person (someone they may not know well) why the numbers were meaningful to them and how the numbers related to each other. Later in the workshop, in taking an example from culture, we were able to pose an open-ended question for them e.g. a fisherman has 12 fish to share with 4 closely related families with different needs, how might 12 fish be shared between 4 families? (sharing taro is an alternative for highlands regions). In the assessment section we share another open-ended question: a farmer can see 20 animal legs under his fence, what animals might be behind the fence. In response to these experiences, teachers have said “that was the first time I had a question in maths that had more than one answer”, “that introductory activity was an eye-opener for me”. We found all teachers participating, laughing, and recording their ideas, sometimes prompted by another teacher or the facilitator to encourage them. They were willing to share their ideas, where they had to think, and how they thought.

Group activities with participant and facilitator questions. Once small groups have a go at the questions mentioned in the previous paragraph, the facilitators demonstrate the use of questions to draw out the mathematics of a cultural or open-ended activity. Throughout the workshop, the teachers were introduced to activities that were appropriate for young children learning. As they had a go at these activities, the facilitators demonstrated the role of the teacher who would ask probing questions about the mathematics of the activity or ensured that the teachers, like the children would, asked each other questions. These latter questions often arose as they learnt how the activity actually worked. For example, in number target² each person in the group makes up a two digit number from the digits 4, 5 and 6, and then in turn add or take away from a central pile either a stick (representing the 10 unit) or a stone (representing the one unit) and say the number in three ways (giving place value, normal English, and Tok Ples if the counting system had a specific word for five, ten or twenty). They went around the group until they made their chosen number (number target). Getting to understand how to play this game inevitably resulted in the teachers asking each other questions and the facilitator would listen in and ask a key question such as why they only added a stone and not a stick to which the teacher would refer to place value and what was already there. Teachers comment how learning the games required them to ask each other questions and they also learnt how to ask questions about the mathematics of the activity. We observed the trainers having a go at asking such questions when they were assisting the facilitators to run the workshops. For example, “why did you add a stick?”, or in a two-spinner game with one and two digit numbers, “how did you get that?” In a measuring activity that the teachers themselves planned, they would collect some informal units in preparation and then ask their peers to select something to compare or measure. “Can you find something else?”

² The late English mathematics educator Richard Skemp provided this and a number of other games we used.

“Do you think that leg’s height will be longer than the table length?” “How can you check?” Figure 1 shows groups solving, planning, and facilitating questions.



Figure 1. a. Solving an open-ended question. b. Preparing questions for readers. c. Facilitating the preparation of going further questions.

Reading mathematical books. The teachers were provided with books on mathematical concepts for beginning readers. The picture books included animals found in PNG and typical PNG activities of gardening and marketing. There are some questions in the books to involve the listener. The teachers were shown how to read the book to a class, showing the page and following along the words smoothly with a finger. The teachers were asked to make up some questions (a fact question about one page, one linking two pages, and one that might require outside knowledge). They practiced reading the book to their peer group. The teachers engaged in writing questions and asking them during the practice. However, we observed that most questions were factual or involved a question from other information that was not linked to mathematics e.g. “what is compost?” They also prepared activities linked to the book (some examples were provided on the last page of the books).

Watching videos of children answering questions. The workshops used video material to engage the teachers and to illustrate good teaching practice and how children learn to count and do arithmetic in particular. Questions similar to those in their assessment schedules were shown. Teachers enjoyed watching these children respond to the questions and were often amazed at the fact that children had difficulty with fairly easy questions. We were also sharing some important theoretical perspectives about how children learn to count and do arithmetic similar to the NSW *Count Me In Too* program. In one workshop, teachers really engaged in translating the assessment questions for children into Tok Ples. There was considerable discussion as they did this, they realised the real meaning of a number of arithmetic concepts. The teachers then practiced with their peers asking the questions either in Tok Ples or English. The interesting thing was the way in which the teachers role-played the children, realising that these questions truly drew out typical ways of children answering. Thus they were not only learning about asking questions but also the kinds of answers they might expect from children. In one workshop they were actually able to ask children the questions, and the teachers did well in not teaching (telling) and also rephrasing the questions (they used both English and their local language) and waiting to see if the child could answer.

Having a Go at Asking Questions

Questions for activities involving simple resources. The participants were required in groups to prepare a weekly plan following an inquiry method. They were given several examples with key questions included. The plans were to include steps, questions,

resources, and later they added assessment. Each group included questions. Initially, they would write down closed questions or write down “demonstrate and ask questions” or just “Pupils count as stones or sticks are put in place”. However, with a little prompting, they soon ensured their peers did the activity and they asked their peers to explain what they were doing or what they found out. They wrote, “pupils select two areas to measure.” “Which was bigger? How do you know?” “What will you use to measure?” “Can you give me an example?” “What is the pattern?”

Teaching their plans. In presenting their plans to the whole group, it was evident that they really aimed at providing resources for group work and then in asking questions. These questions were at the beginning of the weekly plan where they engaged their peers by going out to an imaginary community activity to observe and ask questions. Then they prepared questions related to in-class activities where the teachers were further exploring the concept in groups. Finally they asked questions of the whole class as a conclusion for each lesson within the weekly inquiry plan. Trainers often prompted to ensure their fellow group member remembered to ask questions while other teachers read their planned questions with pride and waited for the role-playing teachers to respond. Where the teachers had an opportunity to teach their plans to children, similar questions were prepared and in some cases, they even prompted the children with questions to ask elders who were demonstrating how to plant gardens. It seemed that teachers were learning the importance of really meaningful questions that required some thinking to be answered. This was quite different to single word answers to a number fact. It was interesting as one teacher learnt the technique of open-ended questions, that she first wrote the closed question on the board and allowed some time for children to have a go at answering. Eventually, she had a child give the answer and she wrote it on the board. She encouraged all the children to copy from the board. Some months later, observing her class, the children were not copying questions and answers. They were expected to have a go at her questions, often open-ended. Open-ended questions and responses were displayed around her room.

Connecting with Mathematics

One of the critical aspects of the workshops was an early discussion with participants of a cultural activity and the mathematics within the activity. The teachers discussed this in a small group and then shared. They had some key questions to respond to about the activity. Although this did not particularly engage the teachers in preparing or asking questions, it did mean that the teacher was able to see a connection between their sociocultural mathematics and school mathematics. This provided an early engagement that precipitated a sense of sureness for having a go in the rest of the workshop including writing and asking questions and getting their peers to link the school mathematics to cultural activities.

Teachers also learnt about key aspects of school mathematics and how young children learn this mathematics. The videos certainly assisted the teachers to engage with the theoretical aspects raised in the course but other aspects such as learning how to teach bilingually were also raising teachers’ awareness of children’s engagement with learning. In particular, there were discussions around the children talking mathematics and how the teacher could stimulate the children to talk and explain. Some of this lead teachers to incorporate questions in their teaching that would anticipate children explaining. This came from their practice with the assessment schedule and from watching the videos of teachers

asking questions and also teaching in classrooms. Questions such as ‘how do you know?’ ‘what pattern did you use?’ were included in their plans. This last question was particularly interesting since a surprising number of teachers were not really used to the many numeric patterns that could help children learn arithmetic such as $3 + 5 = 8$, $13 + 5 = 18$ etc. or if $9 + 1 = 10$ then take one away from 9 and add it to 1 means $8 + 2 = 10$ etc.

Discussion and Conclusion

The study was investigating whether principles related to cultural mathematics, mathematical thinking, early childhood education, and early childhood mathematics learning were valid for PNG teachers. All teachers were Papua New Guinean with strong cultural identities and most taught children from their own cultural group. Some from the cities were teaching children of many different PNG cultures and languages and usually the lingua franca Tok Pisin was used. In fact, it was used in many of the schools with only a few teachers attempting to implement the new policy of teaching in English. Teachers varied considerably in their background experiences but were minimally trained. It was found that teachers really valued being able to recognise, value, and link their cultural mathematics to school mathematics. Nevertheless, they needed to learn how to help children recognise this mathematics in more than a superficial way e.g. basic counting of familiar objects. During the workshops, it became clear that teachers were happy to ask questions and that was not culturally inappropriate. I surmise that this might have been the result of considerable group practice in their own primary school education in English where they learnt to ask and answer questions. Furthermore, they were used to debate as issues (from politics to family bride price and land distribution and money-making) were discussed at length, particularly in the men’s houses. However, their position as teacher and the use of rhetoric in large meetings (in this case children with lower status) was the norm. They were also often strict with the children and discouraged free talking. Some teachers regularly demonstrated the concepts but they had not asked in depth or problem solving questions. This was the area that the teachers were beginning to develop.

The observations of their teaching and group discussions, comments from teachers and artefacts (weekly plans, questions prepared as exercises after we discussed open questions, and questions prepared to go with the readers) indicated that preparing in-depth questions was new to them. Each of the opportunities to experience good questions such as open-ended questions with many answers and diagnostic questions that they themselves used and worked on built up a strong experience of such types of questioning. They realised how they could get children to give more than one answer and how the children rather than the teacher were able to decide on the appropriateness of an answer. This was also seen as different from children copying from each other although that was common and some teachers themselves often relied on others (usually with better English) to do the preparing or writing in the group. Nevertheless, those teachers did give input and the trainers were often good at drawing these teachers into the conversation and having a go at presenting a segment of the weekly plan. They had a go at writing these kinds of questions on several occasions during the workshop. Furthermore, these questions were part of the new theoretical learning about what is mathematics, namely mathematical thinking, what are key concepts in mathematics especially in measurement, and how do young children learn mathematics. The fact that the teachers were able to view videos of children answering questions and teachers asking children questions was important. Nevertheless, there was

still a tendency for teacher demonstration with limited responses to questions that were asked rather than the questions being the centre of small group discussion.

It is common practice in these communities for children to learn by observing people carrying out activities, and participating where possible in cultural activities which was a way Sullivan et al. (2013) described some Australian Aboriginal communities. It is also common for the status of a person to be considered when it came to speaking. There was discussion of this issue as part of the unpacking of the principle on cultural capacity and how to discuss with children and parents the purpose of questioning in school. The workshops have shown that teachers are willing to make use of questioning techniques to draw out the mathematics of the cultural activities, and to get children to think mathematically. The theory and practice went hand-in-hand to change practice. The experiences ruptured the general ordered model of teaching to incorporate a new discourse in teaching (Gilles, 2004). While one of the authors is non-Papua New Guinean from a former colonial culture, the changes were occurring as a result of the input of Papua New Guinean teachers. They may have been seen as having some authority by the teachers. Nevertheless, this was a holistic approach to change and not really a new direction but one that built on some existing practices, safe opportunities for new practice, and reasoning for the change. It filled a gap that the teachers themselves perceived, one of linking cultural and known mathematics to school mathematics and one of getting children to actually learn and think mathematically as opposed to meaningless rote learning. It provided a way forward to allow children talking productively in small groups while they thought mathematically.

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