Recognising Different Starting Points in Aboriginal Students' Learning of Number

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Eighteen Aboriginal students, in Years 1 to 11 at a remote community school, were interviewed using standard counting tasks, and a 'counting' task that involved fetching 'maku' (witchetty grubs) to have enough to give a maku to each person in a picture. The tasks were developed with, and the interviews conducted by, an Aboriginal Research Assistant, to ensure appropriate cultural and language contexts. A main finding was that most of the students did not see the need to use counting to make equivalent sets, instead using an 'estimation' strategy, even though they were able to count.

Mathematics is a way for people to "understand and make sense of their environment and their practices through identifying patterns that assist in organization" (Perso, 2003, p. 11). Thus, although Western mathematics is the mathematics generally taught in schools, traditional indigenous cultures have what are often distinctly different ways of making sense of, organising, and acting in their environments. They have different world views and related social practices that impact upon what is valued and used as knowledge, mathematical or otherwise. For example, Australian Aboriginal people use genealogical patterns to make sense of their world; that is, "ordered ways of naming and construing the relationships of natural things according to perceived ancestral or familial linkages" (Watson & Chambers, 1989, p. 30, cited in Perso, 2003). In comparison, many other cultural groups use number patterns based on counting and measurement with a focus on 'quantity' rather than 'relationship' (Perso, 2003).

Malcolm, Haig, Königsberg, Rochecouste, Collard, Hill, and Cahill (1999) suggested that Aboriginal children develop very early an understanding of the sophisticated, complex family and social networks making up their world. For these children, family and kinship relationships are a central component of their cultural background and the ways they interpret and function in their world, including the ways they approach 'mathematical' tasks. The research study reported in this paper arose from observations that some Aboriginal students were able to correctly complete 'counting' tasks without counting.

Treacy (2001) created a task to find out whether students would choose to use counting to solve problems, such as for making an equivalent set. Called the Ice-Cream Task, students were shown a picture of 6 people and asked to go to the 'ice-cream shop' to get enough ice-creams for all the people. The 'ice-cream shop' consisted of a box of cut out paper ice-creams placed across the other side of the room. The process was repeated with a picture of 10 people and then a picture of 14 people.

This task has since been adopted by *First Steps in Mathematics* and used in schools around Western Australia, and in other places across Australia and overseas where the *First Steps* program has been implemented. Two accounts of students' responses are:

> Winona (eight years old) glanced at the picture and after choosing the ice-creams very carefully … brought back six. … For the picture of fourteen I thought she would bring back a handful as she had only glanced at the picture and certainly had not had time to count them. I was amazed when she gave out fourteen ice-creams. She said, 'I didn't count' but could not explain how she knew how many to bring back.

> Victor [pre-primary student] looked at the picture and then went to the ice-cream shop and chose his ice-creams very carefully. He returned to the table with six ice creams and proceeded to hand them out saying 'that's one for the baby, one for the Dad, one for the daughter and so on.'

In both these examples, and in others, there was no indication that the students used any form of 'counting', and yet they were able to complete the tasks correctly. Thus, this research study was designed as a small-scale, pilot study to investigate these phenomena further. More specifically, the study aimed to:

- Examine Aboriginal students' strategies in completing 'counting' tasks similar to the ice-cream tasks; and
- Compare the students' responses for these 'counting' tasks to their counting knowledge and skills.

In the context of these research aims it is acknowledged that referring to the ice-cream tasks as 'counting' tasks is a Western mathematics perspective, since some Aboriginal students are able to correctly complete the tasks without counting.

Theoretical Background

Nunes and Bryant (1996) suggest that children only really understand counting when they know what counting is for and when to use it to solve problems, in particular, when they choose counting to match sets. According to Nunes and Bryant, children initially come to understand number words and counting as a means of quantifying a single set; they then take time to generalise this understanding to the point where they can use it to compare the size of two sets or to construct equivalent sets. Nunes and Bryant suggest that children have to know, not only how to count, but when it is appropriate to count. They suggest that if children do not choose to use counting to solve problems then they have not fully understood the counting system.

The First Steps in Mathematics Diagnostic Map (Department of Education and Training, 2004) supports this view when it suggests that younger students initially ... *do not spontaneously use counting to compare two groups in response to questions such as: Are there enough cups for all students?* when they are in the Matching Phase (3 to 6 years old). However, by the end of the Quantifying phase (5 to 9 years old), they, *without prompting, select counting as a strategy to solve problems such as: Are there enough cups? Who has more? Will it fit?* At this point they trust that the number at the end of the counting sequence will not change no matter how the collection is counted or arranged.

There has been some research (e.g., Ginsburg, 1982) into the idea of using one-to-one matching however, most early number research has focused on using one-to-one correspondence in order to count (e.g., Baroody & Wilkins, 1999; Fuson, 1992; Nunes & Bryant, 1996). More recently, The Model of Early Number Development in Figure 1 developed by Treacy & Willis (2003) includes two pathways into number understanding. However, it does not include one-to-one matching (for example, based on family relationships) as an alternative pathway. It is possible that this should be included in this model, and could be a pathway into number understanding that has been overlooked by educators in general, but particularly teachers of indigenous students. If this is how some indigenous students solve a problem like that presented in the Ice-Cream Task, there are implications for teachers for how they introduce young indigenous students to number learning.

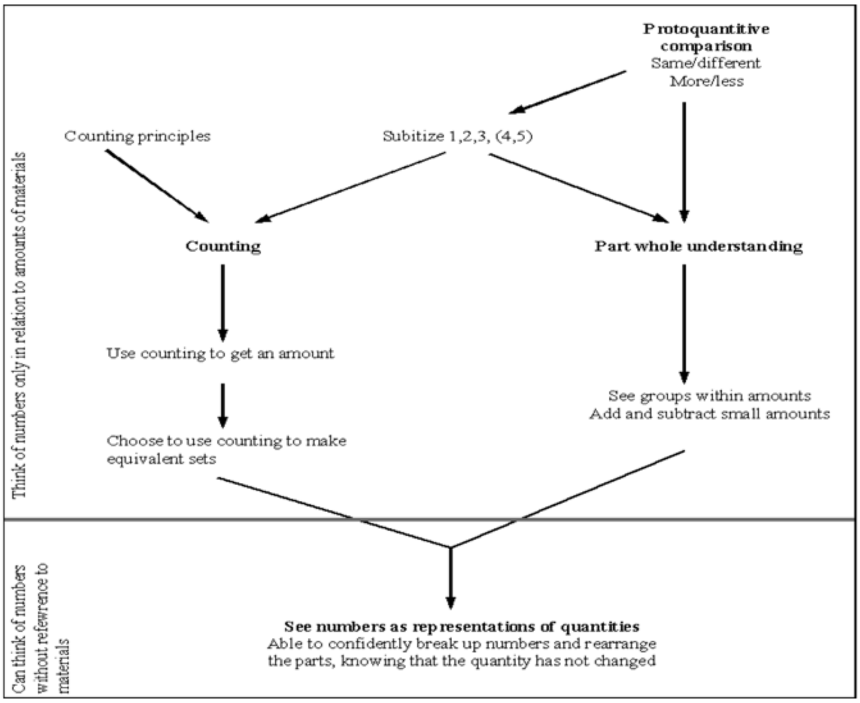

Figure 1. Children learning about number as a representation of quantity – A model.

Thus, in addressing the two research aims, this study was designed to examine if students: choose to use counting; use a matching strategy; use family relationships as a basis; and/or use other strategies in situations like the Ice-Cream Task involving making equivalent sets.

Method

Eighteen Aboriginal students, in Years 1 to 11 at a remote community school in the Goldfields of Western Australia, participated in task-based interviews based on 'counting' tasks. The tasks involved: fetching 'maku' (the local name for witchetty grubs) to give all the people in a picture a maku; identifying a hidden quantity when a part of a collection of maku are covered; and standard counting tasks. This paper does not report on the full findings; for focus, it reports on the maku and standard counting tasks only.

An Aboriginal research assistant who spoke the same language as the students involved in the study (Wangkatha) was engaged to help with the task design and data gathering processes. She grew up in the community and was familiar with all of the students. The ice-cream task was modified to become the Maku Task. The local shop sold lolly versions of the grubs, so these were used instead of pictures of maku. Pictures of the groups of people were constructed from pictures of Aboriginal people that were found in books in the school (see Figure 2). Specifically, the tasks were:

Maku Task. The student was shown pictures with 4, 6, 10, and 16 people and asked to get enough maku for all of the people in the picture. This task was designed to see whether a student would choose to use counting in a situation where it is not obvious to do so.

Oral Count. The younger students were asked to count from one, and the older students were asked what came after a given number, for example, 39, 59, 79, 99, 100, 109, and 199. This task looks at the extent of the student's oral counting sequence.

Get Me Task. The student was asked to get a number of items (maku) and put them in a bag to take home. This task looks at whether the students can use counting when asked.

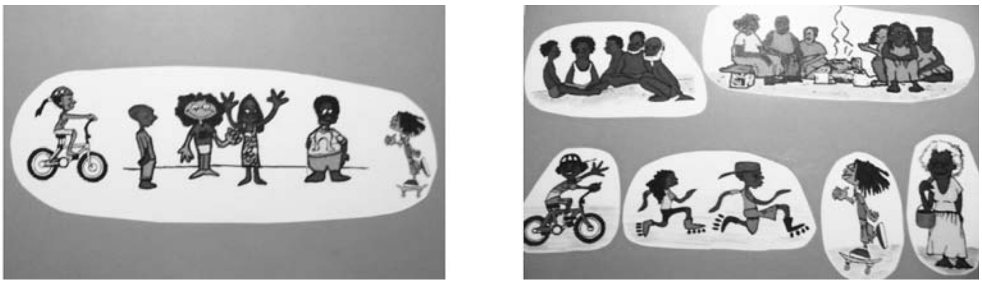

Figure 2. Examples of the pictures of groups of people for the Maku Task.

The interviews were conducted in Aboriginal English and were video taped with permission from the students and their parents. The video tapes were transcribed with the assistance of the research assistant, to ensure a correct interpretation of what the students were saying.

Findings and Discussion

Data from the interviews are summarised in Table 1. It was not always possible to ascertain from the video footage what strategies the students used to complete the Maku Task. Whether they were using a matching strategy or family relationships, the initial foci of this study, it was not possible to say, as the students were not able to articulate enough about how they knew how many maku to collect. However, it was possible to identify if they were or were not using counting, with most students not using counting to complete the Maku Task. In comparison, the students were able to count when asked to get a number of items, and all students, except for the youngest one, could orally count beyond sixteen, which was the largest number within the Maku Task.

Maku Task

Three of the students (see Table 1), Rowena, Justin and Keegan, chose to use counting at some point in the Maku Task to work out the number of people in the picture and then used this count to collect the maku from across the room. One of these students, Rowena, counted the sixteen people in the picture and then collected twenty maku instead of sixteen. When asked how many maku she had, she immediately said twenty. She had put four to the side and knew that sixteen and four made twenty. This suggests that she did not use the count of sixteen people to help her with the number of maku that she needed to collect. Rowena also struggled to use the oral count when she was asked to get seventeen maku. With the oral count sequence, she was able to count to 28, but was not able to continue after this number.

Justin used counting for two parts of the Maku Task, and did not use counting for the largest and smallest part of the task. For the picture of four, he collected two items at a time and brought them back and gave them out. For the picture of 16, he simply grabbed a large handful of maku and then gave them out one at a time. When asked how many maku were in the picture he did not know, and proceeded to count.

Table 1

Summary of the Interview Data

Name	Year level	Maku Task 4	Maku Task 6	Maku Task 10	Maku Task 16	Oral Count	Get Me Task
Ainsley	1	Collected one at a time. Afterwards, counted 4 with prompt.	Collected 3 then another 3. Afterwards, counted 6 with prompt.	NA	NA	10	8
Alana	1	Collected 2	✓ No overt count	11 No overt count	3	20	21
Kiara	2	Brought over the container	7 No overt count	Brought over the container	12 No overt count	29	7
Delray	3	✓ No overt count	5 No overt count	✓ No overt count	12 No overt count	20	9
Tosha	4	✓ No overt count	10 No overt count	11 No overt count	15 No overt count	39 needed written then continued. 59 needed written then continued After 100 -didn't know.	When asked to get 20 she counted one item twice so had 19 maku.
Lana	4	5 No overt count	✓ No overt count	17 No overt count	14 No overt count	49	20
Anastasia	4	✓ No overt count	✓ No overt count	✓ No overt count	13 No overt count	After 109 said 300	16
Gracie	5	✓ No overt count	7 No overt count	✓ No overt count	17 No overt count	After 109 said 200	20
Bernard	6	Bought over the container When asked HM : 4	Bought over the container When asked HM : 6	9 No overt count	18 No overt count	20	21
Stuart	6	✓ No overt count	✓ No overt count	✓ No overt count	12 No overt count	39 needed written then continued. Written 59. After 100 said 200.	21 Counted by 2s to 20 then got 1 more
Arnold	7	✓ No overt count	✓ No overt count	✓ No overt count	18 No overt count	After 109 said 2000	20 Counted by 2s
Rowena	7	✓ No overt count	✓ **COUNTED**	✓ **COUNTED**	20 **COUNTED**	28	17 Counted to 12 then missed out 13 … Said 14, 15, missed out 16 said 17
Justin	7	2 then another 2	✓ **COUNTED**	✓ **COUNTED**	19 No overt count	After 39 said 50, self-corrected 40. After 109 said 200.	20

Janey	9	✓ No overt count	✓ No overt count	✓ No overt count	✓ No overt count	200	20
Keegan	10	✓ No overt count	✓ No overt count	✓ No overt count	✓ **COUNTED**	After 99 said, 200	20 Counted by 2s
Wanita	10	✓ No overt count	✓ No overt count	✓ No overt count	13 No overt count	After 109 said 200	20 Counted by 2s
Tyrone	11	✓ No overt count	✓ No overt count	✓ No overt count	17 No overt count	After 109 said 200	20
Sheree	11	✓ No overt count	✓ No overt count	✓ No overt count	✓ No overt count	After 109 said 200	30

Note: Shaded cells show responses that are either correct, or one more or one less than the required number. Diagonal lines across cells show students who chose to use counting for the Maku Task.

Keegan was able to select the correct number of maku for the first three parts of the task without counting and then chose to use counting for the last picture of sixteen people. After getting the right number for the picture of ten, the research assistant asked him several times to explain how he knew to collect ten maku. He was able to reply by saying that “I bin looked at the picture”. When asked to complete the section of the task with sixteen people, he said in language to the research assistant, “Do you want me to get it right now?” to which she replied, “Yes”. He then said, “Can I count them first?” and she said, “Do what you want to do”, so he counted the people first. It is possible that the questions that were asked of him after completing the task with ten people, one of which was, “Did you count?”, may have suggested to him that he should be doing something other than ‘just look’ to work out how many people.

It is interesting to note that most of the children did not choose to count for this task. Of those that did not choose to count, most of them were able to select the exact number of maku needed each time, or to select one more or one less than required. This suggests that for most of these children, counting is not an appropriate strategy for this type of situation.

So how did the students know how many maku to select? Many of the students were not able to articulate exactly how they knew how many maku. When asked, many of them simply said things like “I bin looked,” suggesting that they looked at the picture and just knew how many. One student, Tyrone, was not able to say how he knew. After bringing back 17 maku for the 16 people in the picture he was asked how many people in the picture and he was not able to say. Instead he counted the people and then said there were 16 people. This suggests that he did not even think about the number of people in the picture when collecting the maku, and yet he was able to get just one more than the required number. He was very near the required number, without thinking about a number.

Another student, Gracie, looked at the picture of sixteen people for a short time and then went to collect the maku. She showed no signs of counting, she did not touch any of the people in the picture, and she did not nod her head or show any other overt sign of counting. She brought back seventeen maku and placed them on the people in the picture. The research assistant asked, “Did you know how many people from the beginning?” to which Gracie shook her head and said, “When I put them in I thought there was seventeen people but there was sixteen”. “Why did you think it was seventeen?” “Because there was lots”. The researcher then asked, “Did you count them to start with?” to which Gracie shook her head and said, “No, too quick”. “So how did you know to get seventeen? What were you thinking over there?” Gracie struggled to answer this question, so was asked, “Did you have a picture of the people in your head?” Gracie nodded and said, “Five men, six women and five kids”.

Oral Count

All of the students in this study, except Ainsley, were able to orally count to at least twenty, which is more than the number required for the largest group of people in the Maku Task. Ainsley did not know what came after ten, which, when considering his age, is not surprising. Interestingly, after Year 4, many of the students knew the counting sequence up to 109, but did not know what came after, with some saying 200, one saying 300 and one saying 2000. The latter student re-thought his response to this question after the task and confessed to the researcher that he knew that it wasn’t 2000 as he was walking out the door, to which she asked, “So what is it?” and he replied, “200 unna”. Two students did not know what came after 100 and one student did not know what came after 99. When discussing this with the students' teachers, they said that these students had been completing three digit addition, subtraction and multiplication, which means that all but one of these students (Janey, who knew what came after 109) would have been completing calculations with numbers that were not in their counting sequence.

Get Me Task

All of the students within the group were able to use counting to get a number of maku when they were asked to. This task was the last one in the interview and the number of maku they were asked to get varied according to how they had responded on the other sections of the task. The younger students, Ainsley, Kiara and Delray, were asked to get less than ten items, which they succeeded in doing. Alana was one of the last students interviewed and it was decided to try asking her to get one more than her oral count of twenty, to see if she could use her count sequence in a purposeful situation. She succeeded in getting 21 maku. The rest of the students were asked to get 16 or more items to see if they could use counting in this situation, to at least the number of the largest set in the Maku Task. Tosha made a small error when she recounted one item twice, whereas Rowena struggled to keep track of the counting sequence while collecting the requested number of items. She counted to 12 then missed out 13, said 14, 15, missed out 16 and said 17, so instead of seventeen maku she had fifteen. Rowena is an older student who has a learning disability, which may explain why she had trouble recalling the counting sequence.

Conclusions and Implications

Most of the Aboriginal students in this study demonstrated specific counting knowledge and skills in the Oral Count and Get Me Task, yet they chose not to count in the Maku Task. Thus, although it was not always clear what strategies they did use for the Maku Task, the findings suggest that they did not see this situation as one in which counting is required. Some researchers have noted that since Aboriginal languages do not have many counting words, many Aboriginal people do not tend to count in their everyday situations. In particular, Malcolm et al. (1999) suggested that, in general, precision is much more central to Western society than in most Aboriginal contexts. It certainly seems that the students in this study were not concerned about precision or exactness, since being 'close' to the exact number (e.g., one more or one less) was sufficient to complete the task. Many of them were able to collect an appropriate number, suggesting that they were looking at the picture and using an estimation strategy to get a quantity of maku that would be 'about right' for the number of people. Gracie's strategy suggests that she saw groups within the group to help her to work out how many maku to collect.

Rudder (1999, pp. 12-14) also noted that Aboriginal people are not concerned with numbers:

> If you asked how many people went hunting together, you would be told all the names of the people and if you ask what they collected they would tell you the names of the different animals or plants they had gathered. … They were interested in the relationship between the things in the group … they knew everyone and everything by name and by relationships so that is what they saw and they didn't worry about numbers at all.

Rudder goes on to say that in a situation such as when turtle eggs are gathered, "It does not matter if different people have more or less that others, No one will go hungry." The Maku task, in which the children were asked to make an equivalent set, is similar to this scenario about turtle eggs. The students did not appear to see the need to count; they simply collected a suitable number of items and then gave them out.

The findings of this study raise numerous issues for future research and for mathematics curriculum and teaching practices, including the following. (1) Since this study has not been able to clarify the question of whether some Aboriginal students use a matching strategy or whether they use family relationships in situations involving making equivalent sets, more in-depth research needs to be carried out that provides appropriate contexts and opportunities for the students to talk more extensively and to disclose more of what they are thinking and doing.

(2) Additional research needs to be conducted related to the findings of this study that Aboriginal students might have a tendency not to attend to exactness. The implications of these findings for teaching practices also need to be attended to, in that it cannot be assumed that Aboriginal students see a purpose for counting; a purpose needs to be made explicit in activities that a teacher uses to teach counting. In this regard there is

also a need to be explicit about different cultural viewpoints, for example, the value and purpose of precision versus estimation or sharing.

(3) Students need to be provided with purposeful counting experiences with quantities beyond 100, to build their knowledge of the patterns in the number system and to connect quantities to this. Purposeful activities will be a challenge to identify for non-Aboriginal teachers, since what non-Aboriginal teachers might think of as purposeful might not be so for the Aboriginal students.

(4) The students involved in this study are very capable students, however they have not had a curriculum that has been focussed on their learning needs. Without support and information, their teachers were planning lessons based on 'western' assumptions. They were not able to recognise what their students brought with them into the classroom, and were not aware of what they should be looking for. Teachers need to recognise the different starting points, and learning needs of all their students. This is difficult when teachers do not share the same cultural background as their students and there is little available information about what they should be looking for. There is a need to value what students can do and build on it, and a need to recognise and accommodate different starting points in number.

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