More Cats Than Fish : But Why?

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1. Introduction

This paper examines the importance of the social context, particularly the place of discussion, for learning statistics in New Zealand primary classrooms.

Inferential reasoning at all levels is usually seen as a key objective of the syllabus, and is especially important for the learning of statistics - hence the title "More Cats Than Fish : But Why?". However, too often statistical work in New Zealand primary schools stops short at the gathering of data and the construction of graphs. Here I shall argue that *discussion* is a vital element which can help children to develop the inferential skills needed for understanding and interpreting graphs. I shall briefly examine documents such as the New Zealand syllabuses, and compare the recommendations there with the guidelines of overseas documents such as the Cockcroft Report and the Nuffield Mathematics Project.

2. The importance of discussion

The Cockcroft Report emphasises the place of discussion in teaching and learning mathematics. Thus, on p.71

> "243: Mathematics teaching at all levels should include opportunities for ... discussion between teacher and pupils and between pupils themselves."

and again on p.89

> "306: ... there is need for more talking time ... ideas and findings are passed on through language and developed through discussion, ...".

Specifically, in relation to graphs, the report says, on p.86

> "293: It is essential to discuss and interpret the information which is displayed both in graphs which children have themselves drawn and also in graphs which they have not ... to discuss in detail what they depict and to make deductions from them."

Similar sentiments were expressed earlier in the Nuffield Mathematics Project publications. For instance, on p.2 of *Nuffield Pictorial Representation*, it is stated "Graphs communicate and the communication must be interpreted. Therefore children should always have discussions on them." Again, on p.12, "Progress made by the children will be largely determined by the amount of time devoted to discussion."

It is interesting to compare these comments with sentiments expressed in New Zealand publications. A similar emphasis did not seem to exist in the national syllabuses (1969, 1972) which refer to discussion only under Topic K. Graphs (Standard 1, Year 3) "Oral discussion based on a study of graphs which have been made by children". Discussion is not mentioned again specifically until Form 2. It is notable also that in *Mathematics in Infant Classes* there is no reference to graphing.

Later syllabuses give more attention both to graphing and to discussion. The Junior to Standard 4 syllabus (Department of Education, 1985b) contends that discussion and sharing of ideas to enhance understanding is one of the better approaches to the teaching of mathematics. Under "Graphs and Statistics, Years 1-2" discussion of the relationships depicted in a graph, and the drawing of inferences, is prescribed. At later levels discussion is inferred as part of interpreting and inferential reasoning. In the Handbook to the Syllabus at Forms 1-2 (Department of Education, 1988) there is a recommended change to build in time for "discussion activities where ideas, methods, and approaches can all be discussed".

3. What happens in the classroom?

We consider two published examples of discussions about graphs in the classroom. Note the teacher's role in the following small group discussion from the first year of *Beginning School Mathematics* (Department of Education, 1985a).

(Teacher)	"Now tell me what this graph tells us."
(Anna)	"What biscuit we like the most."
(Teacher)	"Tell me what she says as I think we could put that at the top. Right now, could you, Carol, tell me what biscuit we like the most? Six here and two here. Which is the most popular biscuit? Which do we like the most?"
(Jane)	"That one."
(Teacher)	"Why do we know that?"
(Emma)	"Cos most people's faces on it."
(Teacher)	"How many on this side?"
(Emma)	"Six."
(Teacher)	"So six on this side. How many on that side?"
(Emma)	"Two."
(Teacher)	"So which biscuit do people like the least?"

(Carol) "That one."
(Teacher) "Just by looking at it. Don't even need to look at it. Can just tell."

I suggest that this is an example of teacher-led talk rather than true discussion and question how much these children are reasoning. After all, much of the framework for interpreting this graph has been provided by the teacher.

In the above example the role of the teacher is important in promoting the opportunity to reason logically. But what other factors need to be considered?

In the next example, taken from another *Beginning School Mathematics* graphing lesson, the group have just finished constructing a graph of different shoes worn by the group. They decided to see whether there are more shoes with laces or with no laces.

(Teacher) "Why do you think people like laces? What's good about them?"

After a slight pause one of the boys in the group suggests:

(Tom) "I know something that is a problem about my laces."

He hesitates. The teacher nods and indicates that he should continue.

(Tom) "That is, quite often when they are done up in single bows they just slip undone."

Later another child suggests:

(Jessica) "Straps would be quicker to undo."

The teacher agrees and asks is that like her shoes. Jessica nods.

The graph they have made clearly shows there are more shoes with laces than not. However, when interpreting the graph and thinking about why this might be the case these young children cannot separate this information from their own experience, and argue at an intuitive level.

4. Commentary

Much has been written about the reasoning capacity of children compared to adults. Indeed, these differences have influenced the development of primary curriculum, particularly in the 60s and 70s. Topics such as graphing were delayed until the age when it was thought children were capable of drawing inferences. Was this delay necessary?

It has been widely claimed that children cannot make deductive inferences like adults because they are egocentric and lack the ability to decentre. Piaget argued that skill in the shifting of point of view is essential for making inferences. Writers such as Donaldson (1983), Bruner (1983), Walkerdine (1982), and Van Hiele (1986) look at

some of the differences between the reasoning of adults and children and identified the skill of self awareness as one. Donaldson writes that it is often hard to judge whether children *know* that they *do not know*. This self reflective capacity is necessary for making formal deductive inferences. Bruner talks about the skill of seeing things from multiple perspectives. He suggests that children are not as skilled in this as adults, while Walkerdine suggests that the adult frame of reference is different to that used by children.

In talking about a child's reasoning processes, Van Hiele points out that:

> "... although they reason in another way than we do, they sometimes make connections that are productive and that an adult does not expect. But it is the adults who see their full significance ... they are not aware of the importance of their thoughts."

What place has discussion and context in enabling children to reason inferentially? Pirie and Schwarzenberger question whether mathematical discussion is in fact an aid to understanding. They argue that much of what occurs in mathematics lessons is not in fact true discussion, but is merely teacher-led talk, as in our first example.

I contend that there is a link between discussion and understanding. Walkerdine (1982, p.129), in examining the role of language in providing contextual cues for reasoning, argues:

> "Young children are able to reason in familiar contexts not because they possess reasoning 'skills' which are contextually bound, but because their learning involves being able to adopt positions in discourse in relation to familiar practices and to operate accordingly."

Donaldson differentiates between what she describes as "embedded" and "disembedded" language and reasoning. "Embedded" language and reasoning take place in a context, and enable the young child to participate in more difficult logical exercises, such as negation. She claims this would not be the case if the exercises were presented in disembedded language, and cautions (Donaldson, 1987, p.107):

> "... and we should not underestimate how hard an achievement strict disembedded reasoning is for the human mind."

The current syllabuses suggest that the preferred context to use is one which is familiar to children. In the section on learning based on understanding (Department of Education, 1985, p.8):

> "When new ideas are introduced, they should be related to the environment and experiences relevant to the child."

That admonition is important for several reasons. The nature of reasoning and problem-solving in the informal setting is different from a formal setting. Several writers have commented that most everyday decisions are not taken formally. Van Hiele prefers to call any reference to problem-solving in an everyday situation "exploration". He sees

this as a preliminary step to problem-solving whereas deductive reasoning takes place at a higher level of thinking. Walkerdine also argues that drawing inferences based on an understanding of everyday social practices (which are a limited base) is very different from formal reasoning.

It seems quite clear then that the kind of reasoning children are applying as part of a graphing exercise is not formal logical reasoning but is often intuitive, as in the second example. While intuitive reasoning may be the classroom reality, particularly with very young children, Bruner considers that it is of equal value to deductive reasoning. He argues for the complementary nature of analytic and intuitive thought while objecting to the devaluing of intuitive thinking by the school system, and says that there is plenty of evidence to show that intuitive thought is something which scientists value. Unlike analytic thought it does not follow careful, well defined steps, but (Bruner, 1983, p.239):

> "... rests on familiarity with the domain of knowledge involved and with its structure, which makes it possible for the thinker to leap about."

5. Conclusion

In all of the publications reviewed, discussion is considered central to the development of understanding in the teaching and learning of statistics, with the everyday context of that discussion stressed. If our aim is to equip children to operate mathematically in their daily lives, then the reasoning processes we need to foster should not be too formal but should more closely match those used in an everyday context. This will suit our aim of relating new ideas to the child in his or her environment. As mathematics educators we need to be aware of the nature of true discussion and the implications it has for classroom practice and curriculum development.

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