Recognition of Effective Group Discussion

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This case study reveals difficulties teachers face recognising effective group discussion. The overall study, of which it is a part, examines the discussion occurring during a group activity designed to reduce misconceptions related to division. Groups of children were videotaped, card placement identified and transcripts coded for mathematical aspects of the discourse. Characteristics of effective group discussion were compared with the discussion occurring during the group activity and related to learning outcomes. Once again learning outcomes vary for the group members despite the children's active engagement with, and discussion of, the task. Teachers are alerted to the complex nature of student participation in and outcomes of group learning.

Small group learning has been promoted as a classroom activity extensively over the last 20 years. But children still do not necessarily learn from group work. The competent teacher, who pays attention to training and then grouping children who will work together and who have sufficient knowledge and ability to help each other to solve a problem, may be pleased to see children working and talking together with a well structured task. She may hear snippets of mathematical discussion and feel satisfied that she has created a cooperative learning environment. However, she will know from experience that some children will learn more than others and that they will learn in different ways. Is it possible to further enhance learning in a group situation? Is it appropriate for all students? How can they best be grouped? Is group learning the panacea it is often promoted to be? This paper sets out to discuss why some groups are less effective than others. In particular, it examines the interaction and outcomes of students working in groups to answer some of these questions.

It is interesting and pertinent that in mathematics only a minority of studies have shown a statistically significant difference between achievement in the various cooperative, group learning schemes and achievement in whole class or individual learning. Where significant differences have been found they have usually favoured the cooperative schemes (Davidson and Kroll, 1991). The present study reveals the complexity of student interaction and outcomes in group learning situations.

Some previous studies have focused on the nature of student discussion required to enhance small group learning. In particular, Webb (1991) reviewed many studies of verbal interaction occurring in groups in mathematics. She concluded that giving explanations with evidence, rather than simply giving answers, when helping others was a critical feature of peer interaction. Learning from receiving explanations was not as clear. Vedder (1985) found that its effectiveness depended on whether the explanation, which was requested, was understood and whether the target student has and takes an opportunity to use the explanation to solve the problem. Farivar and Webb (1993) developed a training program to enhance small group learning which incorporates these findings.

Gooding and Stacey (1993) found that sufficient knowledge to be able to discuss the mathematical content of the task was essential for effective learning. Students needed adequate background knowledge to participate and to share this knowledge so as to not be ignored or excluded from the discussion. They also needed to receive appropriate explanations when they required them and to use these newly corrected ideas during the activity, for example, to help others.

Teachers have been exposed to the social aspects of group work. Their awareness has been drawn to factors which promote effective social interaction such as children listening to each other, taking turns and encouraging others (Dalton, 1985). They have had their attention drawn to hearing the buzz of a cooperative classroom. These sorts of instructions help teachers provide a good environment for learning but learning the subject itself is the crucial feature of group work. How can teachers engage their students in learning the subject matter? Can teachers easily recognise effective discussion?

Method

Interactions of students working in groups of four on a mathematics task will be explored in this paper. It is part of a larger study which mapped learning through a series of two cooperative activities and a teacher lead discussion.

One class of 24 grade 6 children (average age 11 years) was selected for the controlled study. The class had had considerable experience of group work in mathematics. Four single sex groups of four children were withdrawn and videotaped working on the activity. Two cameras were used. One focussed down on the group doing the activity and the other on the children's faces. Two of the groups repeated the activity four weeks later. Later, the children's teacher revised the test with the whole class and audiotaped the session. A control group did the test and participated in class work only. A test was developed and administered five times over a period of five and a half months. This paper looks at the progress of only one group, in order to illustrate the patterns of interaction and behaviour that contribute to effective learning.

The study is concerned with small group work designed to overcome misconceptions in mathematics. Many misconceptions have been documented in students' mathematical thinking, and their persistence indicates that traditional teaching methods do not address these well (Ball, 1990; Hart, 1981). Small group discussion can allow children to expose their misconceptions and begin to resolve them through discussion. Bell (1986) has experimented with the design of activities which invoke cognitive conflict in children holding misconceptions. A modified version of one of his tasks, a board game to overcome misconceptions about division, is used in this study (Figure 1). Children were required to place a selection of 7 or 8 cards each, covering the range of rows and columns on the board. The board had the headings and a selection of six cards in place (shown in bold) to guide their placements.

EXAMPLE	WORDS	$\div$	ANS	$\overline{)\ \ }$	ANS
8 apples are shared between 2 boys. How many apples does each boy get?	**8 divided by 2**	$8 \div 2$	4	$2\overline{)8}$	4
2 apples are shared amongst 8 girls. How much apple does each girl get?	2 divided by 8	$2 \div 8$	$\frac{1}{4}$	$8\overline{)2}$	$\frac{1}{4}$
What is 6 divided by 12?	6 divided by 12	$6 \div 12$	$\frac{1}{2}$	$\mathbf{12\overline{)6}}$	$\frac{1}{2}$
You have $12. Each present costs $6. How many presents can you buy?	12 divided by 6	$12 \div 6$	2	$\mathbf{6\overline{)12}}$	2
30 kilometres are split into 6 kilometre sections. How many sections are there?	30 divided by 6	$\mathbf{30 \div 6}$	5	$6\overline{)30}$	5
6 kilometres are split into 30 sections. How long is each section?	6 divided by 30	$\mathbf{6 \div 30}$	$\frac{1}{5}$	$30\overline{)6}$	$\frac{1}{5}$

Figure 1. The group task.

Each group of children was introduced to the activity by being given an opportunity to practise and discuss placement of a row of cards with addition headings and an addition example. Then the addition signs were replaced by Rahn's ($\div$) and the lunar ($\overline{)\ \ \ }$) division signs to give the board as shown in Figure 1. A selection of six fixed cards was placed on the board shown in Figure 1 in bold type. Each child was given a set of cards from the range of headings and questions which included both whole number and fractional answers. The children were requested to talk about the activity as much as possible.

After completing the board the children were presented with a second, almost correct, board. They were told that it had been completed at another school and asked if they agreed with it, to give them an opportunity to correct their own card placements and discuss any remaining misconceptions.

Transcripts of the videotapes were coded, and analysed, for amount and types of utterances, gestures and card placements. The amount of talk was determined from the transcripts from the number of 'turns talking'. It was possible to establish the amount of talk for each child. Card placements and later movements of the cards were counted for each child. The transcript was coded for the number of mathematical statements made which included statements from the number (not 'words') cards, calculations of answers and statements, combined with gestures, pointing to order of division. Explanations about card placements and the mathematics were coded and counted for each child.

The test comprised 35 items. Graphs of raw test scores, divided by five, plus the number of concepts attained were plotted against time (weeks) in Figures 2. The tests were analysed for understanding of the order of division operation and numerical aspects. Examples of the test questions are given in Table 3.

Results

The overall scores showed that the activity improved learning compared with the control, but the revision was very effective. This paper concentrates only on group 2, which was the least effective of the groups, to examine the interaction and learning that occurred.

Group 2 was the least effective group and some of the factors which limited their learning can be identified by examining details of their results and their participation during the activity. Figure 2 shows that Eshan had a perfect score throughout the 25 weeks. Jonathan was absent for tests two, three and the revision, so there is insufficient information available about him immediately after the activity. Peter improved and Michael scored less after the activity, and, like Peter, improved with the revision. Is the limited learning of this group due to the children's level of understanding or to their interaction?

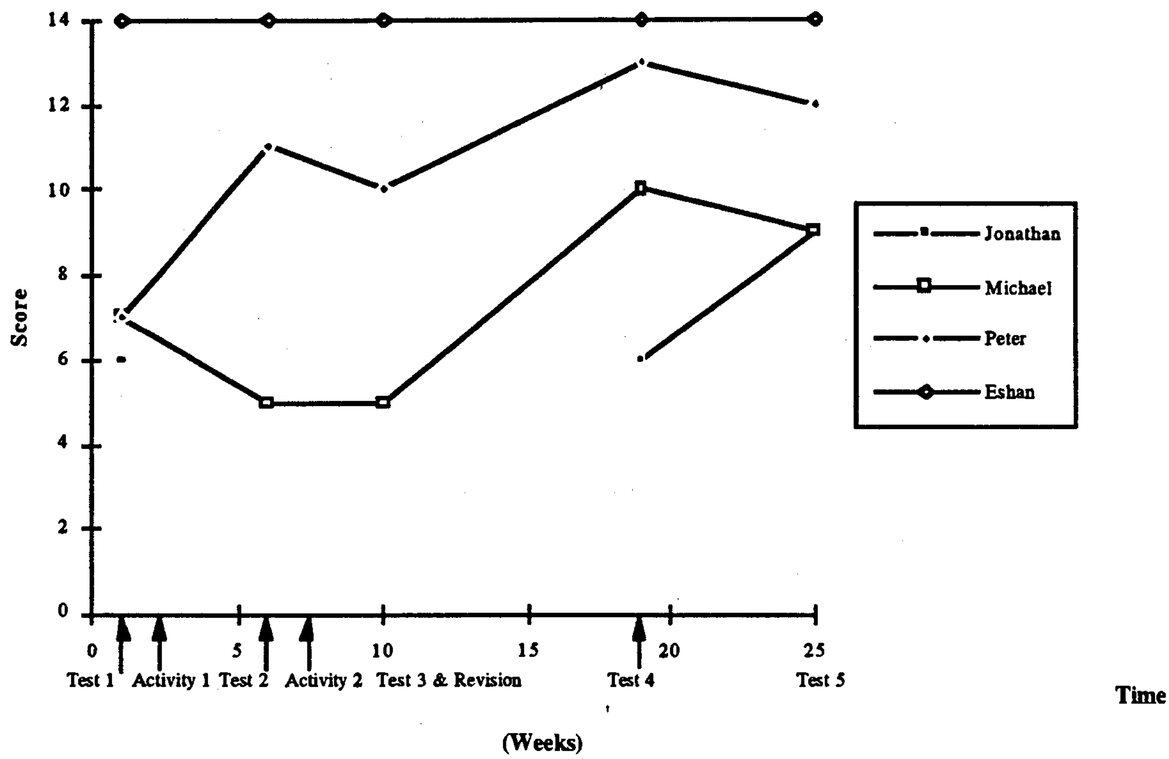

Figure 2. Test Results (The dotted line shows Jonathan's absence.)

Table 1
Participation during the activity.

Name	% talk	% cards placed	Mathematical statements - correct	Mathematical statements - incorrect	Explanations with evidence
Eshan	34.5	31	8	0	5
Peter	34.5	28	9	1	7
Jonathan	18	20	1	2	3
Michael	13	20	0	0	0

Table 1 reveals crucial aspects of group two's participation during the activity. It shows that Eshan and Peter demonstrated their superior understanding during the activity. The video shows that they participated enthusiastically, dominated the discussion and placed and moved more cards than Jonathan and Michael. They made more mathematically correct statements and gave more reasons for placing and moving their own and others' cards. It is interesting that Peter, Jonathan and Michael's participation was so different in quantity and quality during the activity when their background knowledge, identified from the first test, was similar. Their participation and achievement related to their background knowledge.

Group 2 placed and moved the 30 cards, which the children shared at the beginning, in 64 card placements to complete the board. This was the second greatest number of moves for all four experimental groups. They put cards under headings as instructed initially but ignored the horizontal cues about which rows, and hence questions, the cards matched. The excerpt from the transcript included here reveals their participation during card placements 48 to 51. Card placement 57, which occurred later, is also included. The cards were placed correctly in row two during the following discussion.

73. P *Hang on, hang on, 2 divided by 8.*

74. M *There's 2 divided by 8* (referring to [2 divided by 8])

75. P (To Eshan, holding [$8\overline{)2}$] *Put it there*

76. E (Card placement 48 [$8\overline{)2}$ √)

77. M (Card placement 49 [2 divided by 8] √) *2 divided by 8, yeah*

78. J (Card placement 50 [2 ÷ 8] √)

79. P *I haven't got any cards left so I can't...*

80. J (Pointing to [2 ÷ 8]) *That'd be a half wouldn't it?*

81. E *2 divided by 8. That's a quarter.*

82. J *Oh.*

...102. P (Takes [$\frac{1}{4}$] from Michael and places it. Card placement 57 [$\frac{1}{4}$] √)

Michael

In this segment Michael read the [2 divided by 8] words card a number of times whereas Jonathan checked a small/large calculation and Eshan corrected it. Michael did not engage in this level of discussion. Peter directed Eshan's placement of $8\overline{)2}$. Michael did not copy Eshan's placement of [$\frac{1}{4}$]. Peter took Michael's card and placed it later preventing Michael's chance to participate at this level. It is clear that Eshan, Jonathan and Peter recognised [$8\overline{)2}$] and [2 ÷ 8] as [2 divided by 8]. There is no indication that Michael did.

Michael's participation was limited to struggling to understand the questions and word statements that derived from them. He placed them correctly, moved them to the next row and then moved them back. Although he made mathematical statements, they were not included in the count because he simply read a 'words' card. He did not calculate verbally or explain the order of division operation, which were judged as mathematical statements, as the others did. Nor did he seek help during the activity as the other boys did. The test results, summarised in Table 2, revealed that Michael's spelling and some aspects of his understanding of mathematical language were poor.

Table 2
Michael's Test Results

Category	Example	Number of items correct on test		
		Pre-test	Post-test	Test after revision
Rahn large/small	$8 \div 4$	3	0	5
Lunar large/small	$4\overline{)8}$	4	0	4
Rahn small/large	$4 \div 8$	1	0	4
Lunar small/large	$4\overline{)8}$	1	0	4
Word answers	Write in words $30 \div 6$	5	6	5
Words to numbers	6 cakes are divided amongst 12 girls. How much cake does each girl get?	1	0	1
Words to numbers - Rahn	How many 2s in 8?	4	2	2
Words to numbers - Lunar	5 divided into 15?	4	2	4

Details of correct and incorrect answers on the pre-test revealed that Michael was aware that division was not commutative and that some answers were fractional but he could not divide accurately and was confused about the order of operation for Rahn's sign. After the activity he realised that the division signs operated in opposite directions but worked them out the wrong way round. He corrected this after the revision. It is possible that the activity sensitised him to learn from the revision. His cognitive conflict was resolved after the revision even though he did not participate in it.

Eshan

Despite his comprehensive knowledge Eshan made many mistakes during the activity but persisted and corrected them. Eshan was a good teacher. He corrected Peter and Jonathan when they made mistakes that he could see or hear, but he did not know what Michael needed to be told or shown to help him learn.

Peter

Peter became confused during the eight weeks between tests two and three. He had both signs operate in the same direction (Rahn's) in test three. He resolved this after the revision in which he, unlike Michael, did participate. Peter helped others. He gave the most explanations with evidence but these were not always when or in sufficient depth that the other boys needed to be given them. The explanations helped the group complete the board but certainly did not help Michael learn. It is possibly unrealistic for an 11 year old child to be such an effective teacher at the same time as he is learning himself.

Jonathan

Jonathan participated well and was corrected earlier when he read [$2\overline{)8}$] as '2 times 8'. He participated more than Michael and even sought help. Peter and Eshan's corrections are likely to have helped him. He improved overall despite his absences.

Discussion

Although the trend in the results showed that the experimental groups improved more than the control, group 2 made the least gains. Group 2 was an acceptable grouping of children. There was sufficient knowledge, good will and spontaneous helpfulness to make it an effective group. Each boy's verbal, organisational skills, recognition of visual cues and degree of confidence in participating in the activity was unique. Three boys had similar backgrounds but they participated and learnt differently. Michael was confused by the activity but the revision was very effective for him. This demonstrates the need for teachers to use a variety of strategies to help children learn.

A teacher observing this group in a busy classroom may judge it to be effective. She would see and hear Michael participating in the activity, talking and placing his cards similarly to Jonathan. She would not necessarily realise that he was only able to place the word cards and not the symbol cards. She may not realise that he either could not work out the calculations under the pressure of the activity or that he was prevented from doing so. The other boys were keen to work them out and place them for him.

Unlike the other boys, such as Jonathan who asked if 2 divided by 8 was a half, Michael did not seek help during the activity. Michael was only able to participate partially. He did not take risks with mathematics with which he was not confident, but the teacher would only know this by making detailed observation over a few minutes. The teacher would need to carefully watch and listen to Michael and observe that Peter gave directions rather than explanations to Michael.

The teacher may think that her efforts to structure the learning environment will help everyone academically. However, it is impossible for a teacher to be aware of everything that is happening when a class of children is involved in group activities. Although the teacher is likely to be aware of the skills and knowledge of the children in her class, there is the possibility of her being misled or lulled into a false sense of satisfaction that they are learning when she observes them participating.

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