

Students' Views of Learning Mathematics in Collaborative Small Groups

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Approaches to mathematics teaching which offer an alternative to stating facts and demonstrating procedures have been criticised for undermining the base for teachers' sense of their own effectiveness. Data from an ethnographic study of the classroom practice of an experienced teacher of mathematics who has developed an inclusive (or emancipatory) pedagogic approach indicate that while establishing collaborative groups in the classroom may take some time, students across the attainment range come to appreciate the effectiveness and efficiency of working in such a way. This is in some contrast to research findings about using cooperative groups, a quite different method of teaching. Such findings may support other teachers of mathematics developing an alternative pedagogic approach.

Introduction

The ways in which the actions of the teacher impact on the learning of the students in their class is reasonably well-documented, at least in general terms (see Brophy 1986 or Sylva 1994 for reviews). The development in mathematics education of a model of inclusive pedagogy (Murphy and Gipps 1996, Solar 1995) entails the teacher employing such actions as open-ended, problem-based learning within collaborative small groups. This pedagogical approach is designed with the intention of securing the success of all pupils in mathematics.

Such an approach is quite different from what Smith (1996) calls teaching by "telling", where the teacher's main role is stating facts and demonstrating procedures. Smith argues that teaching by "telling" provides a clear-cut basis on which teachers can build a sense of efficacy, the belief that they can affect student learning. Basing teaching on "telling", Smith suggests, builds a sense of efficacy for teachers by defining a manageable mathematics content and providing clear prescriptions for how to teach that content. In Smith's terms this means that adopting an inclusive pedagogy "undermines the base for teachers' sense of efficacy that teaching by telling provides" by de-emphasising "telling". This suggests that research is needed on how teachers who have adopted an inclusive pedagogic approach build new foundations for their sense of efficacy in teaching mathematics.

The research results presented in this paper may contribute towards what Smith has called a central question for empirical studies of mathematics teaching: how teachers who have moved away from teaching by telling are able to "reconceptualise their causal agency in teaching mathematics". The conclusions also point to what might be a fundamental difference between collaborative and cooperative group work in mathematics. The data come from a collaboratively designed and carried out ethnographic study of the classroom practice of an experienced teacher of secondary mathematics (see Edwards and Jones, in preparation). The aim of this component of

the study was to document the views and opinions of students who had experienced collaborative small group work as a means of learning mathematics through being taught by a teacher who had an inclusive pedagogical approach. In this paper we show how well the full range of students understood the effectiveness and efficiency of collaborative small group work as a means of learning mathematics. Yet, it seems, such understanding took some time to develop. These findings may prove useful for other teachers of mathematics seeking to adopt an inclusive pedagogy by suggesting a basis upon which they can judge their efficacy.

Theoretical Framework and Related Research

In attempting to understand the complexities of learning in schools, knowledge of the student perspective has come to be seen as crucially important. As a result, children's understanding of classroom processes and their own role in learning have become an area of increasing study (for examples, see Brown 1995, Christou & Philippou 1998).

An inclusive (or socially-just or emancipatory) pedagogy is being developed from work in feminist and other emancipatory endeavours. With such an approach, the teacher is intent on recognising and valuing a plurality of forms of knowledge and ways of knowing (Becker 1995, Povey 1996, Solar 1995). In the mathematics classroom, this might entail using open-ended, problem-based learning based on social and environmental curriculum contexts using collaborative team approaches within a diversity of teaching and assessment methods.

Some of the theoretical basis for this pedagogic approach comes from the socio-cultural, Vygotskian field. For example, collaborative group work, in which students work jointly on the same problem at all times, is linked with ideas such as situated cognition, scaffolding, and the zone of proximal development. As Damon and Phelps (1989) make clear, this is fundamentally different from cooperative learning which refers to distinct principles and practices such as specific role assignments in a group, and goal-related accountability of both individuals and the group.

A good deal is known about cooperative small group learning (for reviews, see Good, Mulryan and McCaslin 1992, or Cohen 1994). Much less is known about collaborative small group work (Lyle 1996). As a result, little has been reported about a range of issues such as how the composition and dynamics of groups affects their ability to function effectively (for a recent report, see Barnes 1998), or whether the students themselves find it an effective way of working. What is known is that the composition of collaborative groups needs careful consideration, and that there is a vital role for the teacher in establishing collaborative group practice, planning such work, and choosing and structuring appropriate tasks.

The study reported in this paper was designed to elicit the views on collaborative group work from secondary school students who had been taught for varying lengths of time (from two to four years) by a teacher who had developed an inclusive pedagogical practice. A study of students' perception of *cooperative* small group work in mathematics by Mulryan (1994), which involved interviewing students in

secondary mathematics classrooms, was designed to gauge the consistency of their understanding of the processes of cooperative work with that of their teacher. Mulryan found that with cooperative group work the perceptions of high achieving students were more in line with those of their teacher than those of low achieving students. Such a finding might suggest that *cooperative* group work could *increase* the separation between high and low achieving students, a possibility implied in other studies of cooperative learning (Good, Mulryan and McCaslin 1992 p172-173 and 176-177). One aim of the study we report in this paper was to examine the perspectives of both high and low achieving students who had experienced *collaborative* group work in secondary mathematics for a considerable period of time to see whether there was a difference in their perceptions of working in such a way.

Methodology

An ethnographic case study using semi-structured interviews was most suitable for this research for two reasons. First, it allowed the students to say what they wished about their experiences of collaborative group work within the framework of the interview schedule (Hammersley & Atkinson 1995 p25). Secondly, semi-structured interviews are known to be suitable for gathering information and opinions and exploring people's thinking and motivations (Drever 1995). Strict procedures were adopted for the interviews in order to minimise any potential bias introduced by the interviewer.

The sample

A random sample of seven students were chosen for the study, selected from the classes of a teacher who taught in a UK inner-city comprehensive secondary school whose mathematics results in national testing were approximately in line with the national average. The classes from which the students were chosen were a Year 11 low attaining class (students aged 15-16) who had experienced small group collaborative work in mathematics for the previous four years, a Year 10 high attaining class (students aged 14-15) who had experienced small group collaborative work for the previous three years, and a Year 8 middle attaining class (students aged 12-13) who had experienced two years of small group collaborative work. The seven students were selected in the following way: two from the low attaining Year 11 group, three from the high attaining Year 10 group, and two from the middle attaining class Year 8 class (attainment was defined by the school in terms of performance on standardised non-verbal reasoning tests). All the students had been taught by the same mathematics teacher throughout their experience of collaborative group work in mathematics.

The interview

An interview schedule based on the headings used by Mulryan (*ibid*) was utilised as a set of general prompts. Questions were based around the following pupil perceptions:

- perceptions of the purpose and benefits of collaborative small group work in mathematics

- perceptions of teacher expectations for appropriate student behaviour during small group work
- perceptions of the characteristics of small groups that are important for successful groups
- perceptions of the extent to which individual and group accountability exist in small groups
- perceptions in relation to the stability of membership of small groups

The opportunity was also offered to the students for more open comment on their experiences of collaborative small group work.

Analysis of data

Following transcription of the audio tapes, each response was systematically coded for a particular category or categories. These categories were developed in an on-going way as new student respondents contributed different categories until there was a stable set of categories. This process of grounded theorising was necessary as the sample size was too small to use the particular categories devised by Mulryan, who, even with a sample of 48 students, had no more than 5 responses in any one category. As part of this analytical process, some categories were grouped to reflect similar themes.

The following grouped categories were amongst those identified from the interview transcripts:

- Benefits of working together/ collaborating/ working as a team/ working as a group.
This theme was evident in all seven respondents' descriptions of their experiences of collaborative group work. For example, R (low attaining Year 11) said "I think its really good, because we're able to work ... as a team ... you just understand more about maths than you do just by writing down on pen and paper". S (high attaining Year 10) said "you might only look at a problem one way, but ...if you give lots of different people a problem, and they look at it in .. different ways". V (middle attaining Year 8) said "it's lot easier to work in a group because you can help each other and you can find out the answers and make sure yours are right".
- Putting ideas together/ contributing/ using different skills (described as a process).
As for the theme above, this was widespread throughout the transcripts. R (middle attaining Year 8) said "you put all your ideas together, and by putting everyone's ideas together, you come up with good ideas and just get good knowledge". R (low attaining Year 11) describes a similar experience, "and even if one person did say ... this is the right answer, we wouldn't just write it down, you'd, you know, make it more deeper and everybody'd put more to extend the answer". J (high attaining Year 10) related that "K came up with an idea once, and then we .. started working on that, and then other people ... put in other ideas on top of it, so we were always building up".
- Listening to/ respecting others in the group/ sharing knowledge.

This theme is distinct from merely recognising the skills offered by others. It is described by R (middle attaining Year 8 class) in the following way: “We can all listen to people’s ideas, which I think is good and ... we all bring up our own ideas,” and in the high attaining Year 10 class by S: “people come up with different ideas ... and you get to explore other people’s ideas which helps”. Z (low attaining Year 11) said “someone would say [something].. and then we all would .. put our different words in and talk about it”.

- Confidence building/ feeling successful/ being motivated

Some pupils, including the higher attaining students, described collaborative group work as a vehicle for increasing their mathematical confidence. For example, L (high attaining Year 10) said “I think in my case, ... if I know someone else thinks the same thing, I’m more confident about what I think”. There were several instances of pupils describing the experience of group work as making them feel more successful. J (also high attaining Year 10) explained “I just think its better than working by yourself, really. I think you learn a lot more”. Pupils also seemed to find the group dynamics a more motivating learning environment. Z (low attaining Year 11) affirmed “we just didn’t want to leave it ... we used to stay behind lessons ... we wanted to get the work done ... I prefer doing maths ... with group work ”.

- Friendship/ knowledge of collaborators/ stability of groups.

Questions about group structure revealed that all the pupils believed that their performance in a group was positively affected by working with others who were well known to them. Friendship seemed to provide successful working relationships in the view of all those interviewed. V (middle attaining Year 8) explained “If you’re not friends with somebody, ... you might not get along with them, and they might start getting into a bit of an argument about the answers”. R (low attaining Year 11) said “no others could be as good as working with some friends”. S (high attaining Year 10) said “well, obviously, you’ve all got to get on quite well, you’ve got to know ... I think it’s easiest if you know each other first”.

- Speed/ volume of learning.

Students across the age and achievement range thought that collaborative learning in small groups allowed learning to happen more quickly and that they could learn more. J (high attaining Year 10) summed this up: “I think you learn a lot more, ... I think if people ... work together you can get a lot more done and you ... understand a lot more ... I think its probably quicker, because if you’re working by yourself, it’s you that does all the work,”. R (middle attaining Year 8) said “it’s easier if you do group work because you can get through it quicker and .. get to know a lot more”. R (low attaining Year 11) offered a more reflective comment “I don’t think it’s quick or slow, it’s in the middle, but because it’s like that, you get a deeper meaning, you know what you’re doing, you don’t just skim it over the top”.

Other categories of student response included: helping one another, thinking hard, enjoyment, autonomy and independence, and awareness of the possibilities of distraction. All the students were also aware of the expectations of the teacher in terms of what was appropriate for successful collaborative group work in mathematics.

Discussion

This analysis of the interview transcripts for the categories described above allows some comment to be made, both on emerging global patterns in the student responses and on local patterns within groups. Examples of such local patterns relate to the age of the students and the length of their experience of collaborative small group work.

Overall, the full range of students in this study seemed to recognise the benefits of collaboration. They realised the necessity of listening to one another, felt collaborative working made them confident and successful, and judged that they learnt more mathematics more rapidly by working in that way. There also appears to be clear indications that working with friends, that is working with those with whom you get on well, is important. It may be that this helps with the sharing and respecting of each others ideas and that, in the end, this helps with learning. These benefits of working with friends are noted by Zajac and Hartup (1997) in their review. Whicker, Boll and Nunnery (1997), in their study of cooperative groups in secondary school mathematics, found that their students “disliked having groups pre-assigned and permanent, and suggested alternating group membership”.

Yet the responses of all the groups were not identical. In particular, the responses of the younger students from the Year 8 class, who had only experienced collaborative small group work in mathematics for two years, were different in several respects. These students found it more difficult to articulate their perceptions of collaborative group work. Overall, their responses during the semi-structured interviews were much shorter, less reflective, and demonstrated less understanding of the pedagogic process, than the older students. In addition, the younger students seemed more orientated towards outcome, rather than process or understanding. For example, student V, middle attaining Year 8, said that working in a group means “you can find out the answers and make sure yours are right”, and, later in the interview, that it was more enjoyable to work in a group because “you can get more accurate answers”.

Such responses from the younger students, and the contrasting answers from the older students, may indicate that, in addition to maturation, it takes quite some time for the teacher to establish fully collaborative groups. The research on cooperative groups has already established that simply placing the students in groups does not mean that group work will take place. Indeed a frequent complaint about common practice in UK primary schools is that the pupils are arranged in groups in the classroom yet they do essentially individual work. Training in cooperative working was found necessary for successful cooperative group work, and research on collaborative learning suggests that for collaborative group work some form of teaching of relevant skills is required (Gillies and Ashman 1996). A range of other factors is likely to influence the

successful development of collaborative group work, including, in secondary schools, the experience of the students in other curriculum subjects.

Finally, unlike Mulryan (1994), we found no difference between the perceptions of high attaining students and those of low attaining students. All the students in our sample felt that collaborative group work had a positive effect on their rate of learning and depth of understanding. The reason for this difference, however, may not lie solely with the grouping structure. In our study it is likely that the philosophical and epistemological stance of the teacher, in developing a strongly inclusive pedagogy, is the influencing factor.

Concluding comments

Smith (1996), in calling for research on how teachers, who have moved away from a pedagogic approach based on “telling”, build new foundations for efficacy in teaching mathematics, suggests that studies should focus on “how teachers themselves *see and understand the effects of their practice on students*” (emphasis in original). In the case of the teacher in our study, one of the ways the teacher judges her efficacy is in terms of the success of the collaborative group work for all her pupils. Hence our focus in this paper on the student perspectives of working in collaborative small groups.

It is not the intention of this study to produce a typology of categories of student responses, nor to test a theoretical model. Our aim has been to describe the perspectives of secondary school students who have had considerable experience of collaborative small group work in mathematics. It is, in both the sense of the case size itself and in the sense of the time scale used, a “microethnography” (Hammersley and Atkinson, *ibid*, p 46). The lack of comparative cases “necessary for developing and testing an emerging set of analytic ideas” (Hammersley and Atkinson, *ibid* p205) is one difficulty of using a naturalistic situation to study. Furthermore, the data comes from one UK school and hence its generalisability is greatly limited.

Nevertheless, we hope we have provided a useful contribution to research both on collaborative group work in mathematics and on inclusive and emancipatory mathematics pedagogy. Such a pedagogic approach, given its coherent philosophical and epistemological basis, provides the teacher in this study with a strong anchor with which to judge her efficacy.

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