FRIENDSHIP GROUPS AND SOCIALLY CONSTRUCTED MATHEMATICAL KNOWLEDGE

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This paper examines an aspect of collaborative group work arising from a study of peer talk in secondary school mathematics classrooms. The study focused on the extent to which 'exploratory talk', defined as the type of talk which indicates reasoning, occurs in these collaborative groups. One feature of this study, which became evident in transcripts of peer talk and in subsequent interviews with students, was the extent to which friendship groupings supported mathematical learning. Evidence from transcripts of peer talk which indicates this type of support is discussed.

INTRODUCTION

The study was undertaken in secondary mathematics classrooms across Year 7 (11-12 year olds) to Year 10 (14-15 year olds). The purpose was to find the extent to which talk which promoted reasoning in collaborative peer groups, occurred in these groups using a model developed in primary classrooms as a basis for analysis.

In order to contextualise the study, and the description of findings related to friendship groups, it is necessary to describe the particular classroom setting in which the study was undertaken. Learning, in this classroom, occurred in a socio-cultural environment. The teacher actively promoted a constructivist model about the way in which students conceive mutually developed ideas about mathematics. Collaborative group work was the usual mode of working. Groups were self-selected, usually on the basis of friendship unless they became inefficient, in either the group's assessment or the teacher's judgment. Some groups were maintained over significant periods of time, sometimes up to three years.

Problem-solving contexts were the main means of mathematics learning. These 'problems' were either practically based, based on real life scenarios, an investigative situation within a mathematical area or a problem generated by a student. In a socio-cultural and constructivist learning situation, pupils come to recognise that the mathematical process in solving a problem is as important as the outcome. The discussion and sharing of ideas was seen as a vital component of learning mathematics. Inter-group activity (as well as intra-group activity) was a feature of the way the class worked. Groups, and individuals from groups, cross-fertilised ideas during the course of a lesson and, at appropriate times, the teacher drew the class together for a discussion of particular points relevant to all.

Findings from the study suggested that, whilst the model proposed by Mercer (1995) for primary classrooms was evident in a secondary mathematics classroom and explained cognitive 'moves' evident in the talk, the model was not sufficient to explain features of the way social 'moves' were used to support cognition.

BACKGROUND TO THE STUDY

The term 'exploratory talk' was first used by Douglas Barnes (1976) in his influential work *From Communication to Curriculum*. It defined a particular type of talk observed between peers in classrooms which was essentially different from the type of language used in interactions with the teacher in classrooms. Although Barnes' definitions clearly acknowledge a social aspect to learning, his view of learning is Piagetian. He describes knowledge as "accommodated and assimilated" within the individual, "the bringing together of old knowledge and new experiences (or new ways of looking at experience) so that they modify one another". The social construct within which this exploratory talk and subsequent learning by understanding takes place does not impact on his view of the learning process.

Such a social construct *does* influence Mercer's (*ibid*) work on exploratory talk. He applies a Vygotskian view of learning in which language is described as a 'social mode of thinking' to his theory-building based on an analysis of children's talk in primary classrooms. Whilst Mercer is clear about the two separate perspectives: psychological (or thinking) and cultural (or communicating), he argues for their inseparability in functional classroom talk. This is based on what he describes as a neo-Vygotskian view of learning in which there is not necessarily a 'more learned other' involved in the discussion. Vygotsky (and followers of his model of learning) suggest that learning occurs when learners of unequal ability interact. This model of 'scaffolded' learning fails to explain the learning that occurs among peers of equal attainment. The theoretical model must therefore be redefined to accommodate such observed situations. Mercer argues that learning in these situations is based on children having to explain and justify their decisions to each other and describes exploratory talk as exhibiting these features. In his analysis of children's talk, Mercer (*ibid*) defines three types of talk:

Disputational talk is talk involving disagreements and individual rather than collective decision-making. Exchanges are usually brief and consist of assertions or counter-assertions.

Cumulative talk represents a building of ideas based on each other's suggestions aimed at providing a common consensus. Exchanges in this type of talk are usually repetitions, confirmations and elaborations

Exploratory talk is characterised by critical but constructive engagement with each other's ideas. Challenges are justified and alternatives suggested. Joint agreement in decision-making is the end result.

(After Mercer, 1995 p104)

This framework provided the basis for the analysis of peer talk in this classroom and exposed the importance of friendship groupings to the maintenance of mathematical thinking. In the course of the study, the evidence examined in a variety of studies in the UK and the US referred to cooperative and collaborative group work. In many of the US studies, the terms cooperative and collaborative were interchangeable and inferred similar settings. However, the setting in which the study described here was undertaken employed a very different structure for group work.

Collaboration and cooperation

For the purposes of this study, a distinction is made between cooperative and collaborative small group work. For most studies in the literature, it is cooperative groups that are the focus because these are often set up experimentally for the purposes of the study. Damon and Phelps (1989) provide a description for the distinction between these two types of group activity:

> In peer collaboration, a pair of relative novices work together to solve challenging learning tasks that neither could do on their own prior to the collaborative engagement ... Unlike cooperative learning, the children at all times work jointly on the same problem rather than individually on separate components of the problem. This creates an engagement rich in mutual discovery, reciprocal feedback, and frequent sharing of ideas. ... Peer collaboration simulates the challenges of discovery learning; but by providing the learner with a partner in discovery it places these challenges in a context of supportive communication and assistance. (p 13)

Collaborative groupings occur more naturally in a setting and are less contrived or constructed. They are reliant on groups sharing an end goal and working towards achieving that communally. The classroom in which the study was undertaken provided a setting which supported collaborative groups and provided the means through which they engaged and succeeded.

Friendship groups and mathematical learning

Evidence relating to the extent to which friendship groups supported mathematical learning was derived from several situations in the analysis of transcripts of peer talk. The first of these was the level of engagement with the task. ‘On task’ behaviour accounted for between 98% and 82% of group activity which indicated a high proportion of active involvement with the task.

Other evidence was in the type of language used specifically among friends – that which might seem disputational out of the context in which it is said – but which specifically (between friends) is supportive. Examples include situations when one student confesses to being ‘lost’ in the discussion. The response seems negative …

> P: I’m lost
>
> S: Just go home for a bit

… but the audio recording indicates a tone that is understood and recognised amongst friends.

Reassuring laughter appeared to serve to bind the group. This occurred when members of the group realised that what was proposed (by any member of the group) was inefficient or inadequate to move the discussion forward. The communal act appeared to negate individual responsibility for the proposed idea.

Some personal 'name calling', which young adults engage in, also appeared to serve cohesion of the group. Although these names may seem harsh 'on record', they are attributed with affection in the audio recording. Similarly, pleas for the group to 'wait' if a member did not understand what was happening were often ignored. In most cases, the experience of the group took precedence in such activity as, in almost all cases, the 'ignored' member emerged to continue the discussion in a mathematically significant way, demonstrating their cohesion within the group as an individual and as a viable contributor to the discussion.

If we consider the peer talk amongst these groups as mathematical activity which occurs as a spirally growing body of knowledge and activity, there were 'loops' of conversation which occurred outside this activity. One example in an able Year 10 group, consisted of a 'loop' about English homework. In a pause in the mathematical conversation, one member of the group of five asked whether the others had done their English homework. There were responses for approximately 20 seconds before the group fully re-engaged with the mathematics activity. Such 'loops' may serve to provide 'thinking space' for the group before it begins again with the cycle of mathematical thinking.

One aspect of this type of group work validated by other research (Gooding and Stacey 1993) is the extent to which members of groups talk aloud as a 'thread' of activity within the group. Talking aloud seems to bind the group despite its apparent contradictory nature as individuals talk aloud in unison. There is also another form of talking aloud which appears as a 'thread of talk' amongst the group. In the extract which follows, three members of a group are beginning to explain their findings related to routes through a particular rectangular grid in order to visit each site within the grid.

E This goes across … it goes one, two, three, four …

M It goes one, two, three, four,

E …five, six …

M seven, eight, nine …

J And I've noticed with this one, yeah …

E and it goes one, two, three, …

J …you can do *all* of them …

E …seven, eight, nine

J …you can do *all* of them on this one

E all of what?

? [inaudible comment]

[Pause for 3 seconds]

M Maybe it's the way … maybe it's the way you set it out, though

E You can, actually, you can either go like that …

J …like that to reach every single one

E …or you can go in … well, maybe not …

Although there appears to be a lack of consensus throughout this extract, what is happening is the gradual building of shared knowledge by maintaining both their own 'talking aloud' structure but merging it with that of others in the group as a 'thread' so that they are beginning to share an understanding of the situation.

Evidence from interviews

A random sample of students from Years 7,8, and 10 were interviewed about a range of issues related to group work as part of the larger study. One of the questions related to friendship groups, though this had not been a feature identified as important at this stage of the study. This evidence provides support for the social support demonstrated in the transcribed audio recordings.

The degree to which each student knew her collaborators was an important factor affecting their comments about group work. Further probing about changes of group structure revealed that all students believed their performance in a group would be adversely affected by working with others who were not well known to them. Friendship seemed to provide successful working relationships in the view of all those interviewed. V (middle attaining year 8) explains "If you're not friends with somebody, umm, you might not get along with them, and they might start getting into a bit of an argument about the answers, and saying they're right and you're wrong, and you just get into a squabble".

In response to a question about working with others in a group, R (low attaining year 11) says "I think we could have, you know, if we spent two or three weeks getting to know the people ... understand what sort of level they are, what they thought, but no others could be as good as working with some friends, its just, you know, we need to build a bit and then it will be OK". However, S (high attaining year 10) is not so confident about this "Even though I think I'd get to know other people better, and eventually you could work with everyone really well, I mean, people get along differently, I mean, you know, I'm not going to get on as well with some people as I might do with my friends".

In a low attaining Year 10 group, Z says of her collaborators "Because with them, I always got along anyway, ... we've been together four years ... that's fine" and J (high attaining year 10) says "if you get stuck, ... your friends generally, sort of, are on your wavelength, and so they can help you ... a lot more".

This avocation of working with friends is supported by Zarjac and Hartup (1997) whose research found that friends are better co-learners than non-friends because knowing each other well means they know each other's similarities and differences so suggestions, explanations and criticisms are more likely to be better directed. The type of mutual support exhibited generates particular expectations which support collaboration. This is evident in the type of language used amongst friends in this study and in the way in which their mutual language about mathematics is constructed. Friends, in Zarjac and Hartup's study, provided greater security in working relationships which generated more activity in novel problem-solving by members of the group. This is similarly evident through the levels of engagement with the task in this study. Zarjac and Hartup argue that the sense of trust amongst friends is a prop for cognitive development and risk-taking.

Socially constructed mathematical knowledge:

Ideas about socially constructed knowledge, whether socio-cultural or socio-constructivist in settings, such as this classroom, revolve around two major theoretical models, a situated definition of mathematics, and shared cognition. Both models are evident in outcomes relating to the way in which friendship groups work.

Goos *et al* (1996) describe a 'situated definition of mathematics' as an environment which encourages the generation of ideas, testing of these, challenging and justifying in discussion. The emphasis in the classroom is on explanation and communication.

Such a model fits the classroom under study and therefore provides a model within which friendship groups appear to function effectively. Others will argue that all classroom discourse is a 'situated definition of mathematics', including the discourse offered by teachers, if it is a classroom environment which actively promotes a common understanding of mathematics as recognising relationships and connections between ideas, knowledge and processes (Brilliant-Mills 1994). Such environments also promote the necessity of reflection and communication in achieving this understanding.

Shared cognition' is defined by Dillenbourg *et al* (1995) as the "process of building and maintaining a shared conception of a problem" and by Roschelle and Teasley (1991) as "shared conceptual space constructed through shared language, situation and activity". The evidence provided by transcripts of peer group talk amongst friends closely fits this model. The 'threads' of thought and 'talking aloud' which appear to closely intertwine thinking between group members, the use of language particular to friends within each group and the shared ongoing activity in the task despite the apparent 'loss' of an individual who re-establishes themselves later, contribute to a model in which there is shared understanding of thought and knowledge. These definitions are a better fit for the type of 'co-constructed' learning that occurs in collaborative friendship groups in this study.

Conclusion

Evidence arising from this study, though not a focus of the study, raises several theoretical implications for work within friendship groups at the secondary school age. Since friendship groupings occur on a social basis, not a mathematical basis, there is likely to be an acceptable 'cognitive distance' between them in their mathematical cognition. The action of established social interactions on this difference in mathematical cognition will provide a richer mathematical discourse than that occurring within non-friendship groups. Friendship groupings may therefore provide the necessary equal discourse status (through social interaction) and equal task-specific expertise (through 'cognitive distance') that is required for effective use of group skills to learn mathematics.

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