# Exploratory talk in peer groups – exploring the zone of proximal development

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*This paper reports on a study which examined the occurrence of 'exploratory talk', as defined by Barnes (1976) and Mercer (1995), amongst peers in collaborative small groups in secondary school mathematics classrooms (11 to 16 years) in a UK school. This form of talk is thought to contribute to mathematical reasoning. The classroom learning environment in which the study was undertaken is based on sociocultural theories of learning and emancipatory pedagogic practices. The study was undertaken in naturalistic settings during the normal activity of each of the classes. Findings support the neo-Vygotskian view of social dialogic amongst peers as a means of generating talk which culminates in cognitive change.*

## Collaborative groups

The focus of the research is learning in *collaborative* small groups. Much of the research into *cooperative* learning has not made the necessary distinction between cooperative and collaborative, indeed many studies interchange the terms. Since the distinction between collaborative groupings and cooperative groupings is rarely made, little has been reported about a range of issues such as how the composition and dynamics of *collaborative* groups affect their ability to function effectively in relation to cognition (Barnes, 1998). Studies that do so include that reported by Cobb and Bauersfeld (1995). For the purposes of this study, *collaborative* learning is defined as that which is constructed amongst student peers working together in self-selected groups. The process involved in mathematical endeavour is as important a focus to the group as the end outcome. Though the aim is to provide a solution to the activity, the lack of an outcome within a given time frame is not seen as failure, as the collaborative mathematical discussion is viewed as valid mathematical activity and an end in itself.

## Research on talk in peer groups

The benefits to learning of working in groups have been known for some time. In 1981 an influential meta-analysis by Johnson *et al* of more than 120 research studies indicated that group work in learning situations was considerably more effective than competitive or individualistic goal structures. In a comprehensive review, Good, Mulryan and McCaslin (1992, p167) describe "clear and compelling evidence that small group work can facilitate student achievement as well as more favourable attitudes towards peers and subject matter". They advocate a future focus for research on the socially situated learning which occurs in small groups. These authors argue that research on small groups has gone beyond a need to justify its overall benefit through improved learning outcomes. They emphasise the need for work on the factors which affect discourse *processes* as well as factors which affect achievement outcomes. Research has suggested that the composition of the groups and the form of tasks the groups tackle are important factors in determining the quality of learning achieved through such group work (Barnes & Todd, 1977; Cohen, 1994).

Problem-solving tasks appear to provide a productive forum for generating mathematically effective talk in small groups (see, for example, Gooding and Stacey 1993, Mulryan 1995, Pirie 1991, and Whicker, Nunnery and Bol 1997). This remains problematic, though, despite an apparent similarity in approach. Problem-solving can take a variety of forms. In all the studies cited, the ‘problems’ consisted of closed activities. Such use of closed problems is more reminiscent of psycholinguistic analyses of children solving arithmetic word problems than an investigation of socially constructed knowledge.

Much of the research on peer talk in classrooms has been undertaken with young children (three to eleven year olds). Most of the curriculum contexts studied are not mathematical, though there are significant examples of the study of mathematical talk (for example, Cobb and Bauersfeld *op cit*, Lyle 1996). Other studies, such as Maher (1991), are undertaken outside of naturalistic classroom environments and therefore raise questions about the applicability of the findings for secondary school classrooms in the UK. Studies of peer talk in secondary school *mathematics* classrooms are particularly rare, the most influential of these being Pirie (*op cit*).

Longitudinal studies of small group work for longer than a few months are rare in classroom research, though such studies are more common in research on cooperative work at computers, usually with a pair of students rather than a larger group (see, for example, Hoyles and Sutherland 1989). This research on small group activity in the classroom provides evidence of the need for studies in a naturalistic setting at secondary school level reflecting the use of more open activities for problem-solving and a longer time scale for group interaction. It is in such settings that an examination of the necessity for a ‘more learned other’ can be undertaken.

**The zone of proximal development**

Vygotsky (1978) described the social construction of knowledge within a ‘zone of proximal development’. This is defined as “the distance between the actual developmental level as determined by independent problem-solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers” (p86). Thus, in a classroom situation, the actual developmental level can be determined by traditional question-response-evaluation sequences and therefore described. The potential development can only be explained rather than described because it is a process observed in relation to working with others. The ‘next’ developmental level, if achieved, can be described but the process requires explanation rather than description. Achieving the potential is usually described in relation to a ‘more learned other’. Some of the findings from research on small group talk challenge the need for this ‘more learned other’ (see, for example, Lyle *op cit*, Wegerif 1998).

Much of the theoretical basis for a pedagogic approach using small group work in classrooms comes from the sociocultural, neo-Vygotskian field. Collaborative group work (and research in this field), in which students work jointly on the same problem, is linked with ideas such as situated cognition, scaffolding, and the zone of proximal development. As Coles (1995, p165) describes "The social interactions developed in this kind of enquiry stimulate members of the group to think together; from a psychological point of view this pushes forward the level of thinking of each child and 'scaffolds' his or her cognitive processes". Although a Vygotskian view of learning encompasses a broad spectrum from social institutions and cultural influences to group interactions and individual cognition, it focuses on the individual outcome via an interpersonal process. Neo-Vygotskians (for example, Mercer and Fisher 1997, Wegerif *op cit*) have shifted this focus to an understanding of the process of learning within groups of individuals in specific social contexts. The focus here is on the interpersonal relations and their effect on intrapersonal learning within a group objective. These new units of analysis support a means of interacting which involves the whole self and a view of the interactions of a group as a means of cognitive development. The basis for this approach is reasoning as a dialogical activity. The shift is from a Vygotskian framework of self-identity to a neo-Vygotskian assumption of intersubjectivity. This change in focus demands a new methodology - one that moves from description to explanation. The 'exploratory talk' evidence from the study described, here, is used to identify this dialogic as it appears in classrooms.

**Evidence from sociocultural research**

Barnes and Todd (*op cit*) performed an in-depth qualitative analysis of group discussions amongst 13 year olds in the classroom. The standpoint of these researchers was that teachers, rather than learners, traditionally do most of the talking in classrooms, taking "responsibility for the content, pacing, and style of pupil contributions" (p ix). Believing that the teacher does not have to be present for learning to take place, they argued that "children are underestimated", and that "they possess skills and competencies which are rarely called upon in a conventional classroom" (p ix). They hoped to prove that when students work in small groups, without the aid of an authoritative adult, they could take responsibility for knowledge gained and management of the group, because they needed to make judgments, monitor situations, resolve conflicts, and cope with the opinions of others.

In analysing the dialogue amongst the groups of students, Barnes and Todd considered types of speech and their impact on the construction of meaning during group interactions. This necessitated an analysis of both the *social* and *cognitive* functions of conversation. They proposed a system describing speech acts that has been useful subsequently in the analysis of talk sequences. This system is based on two levels. Level one consists of a) discourse moves (such as initiating, eliciting, extending and responding) and b) logical processes (such as proposing a cause, advancing evidence, negating, suggesting a method, evaluating). Level two is comprised of a) social skills (such as competition and conflict, supportive behaviour), b) cognitive strategies (such as setting up hypotheses, constructing new questions), and c) reflexivity (such as monitoring one's own speech, evaluating one's own and others' performance). They identified ‘exploratory’ speech characteristics such as hesitation and changes of direction, tentativeness in voice intonation, assertions and questions made as hypotheses rather than direct assertions, invitations to modify or surmise, and self-monitoring and reflexivity. Barnes and Todd proposed conditions for *collaborative* work amongst groups in classrooms, based on this empirical evidence. Further analysis (Barnes and Todd, 1995) provides descriptive examples of the “... four categories of collaborative moves: initiating, eliciting, extending and qualifying”.

Several authors have suggested that children’s facility in collaboration may relate to the social structure of particular classrooms that do or do not support collaborative interaction. For example, Forman and McPhail (1993) speculated that fourth graders’ difficulty in collaboration on mathematical problems may have been because their traditional classrooms provide little support for engagement in the sort of dialogue involved in collaboratively solving problems. It is important to note that the emancipatory classroom environment, in which the children in the study reported in this paper were immersed, provided a setting which allowed collaboration to occur and for it to be controlled and monitored by the groups themselves.

Following ten years experience of supporting collaborative group work in primary school classrooms, Lyle (*op cit*) studied classroom organisation and task structure related to the use of small group activity and the composition of small groups. Working in a theoretical perspective of a Vygotskian ‘zone of proximal development’, Lyle challenged the necessity for a ‘more learned other’ and cited a group of four boys studied as evidence that cognitive growth can occur amongst participants of equal status. This is borne out in the study reported here.

## The study

Students in this study attended an inner-city girls’ comprehensive secondary school (11 – 16 years) of approximately 1070 students in the south of England. The school population represented a very wide social mix, with the majority of students of white background, though there was a significant minority of 22 per cent Asian students and a total non-white ethnic minority of 25 per cent. Students in the classes studied experienced a problem-solving mathematics curriculum. The sociocultural and emancipatory learning environment involved students taking considerable responsibility for their mathematics learning. Small group organisation within classes was on a self-selection (usually friendship) basis. Classes undertook normal mathematical activity throughout the study. At two points over a period of a year, small group talk was audio-recorded for all of the sessions relating to a particular problem-solving activity for each class. This involved from three to seven consecutive lessons for each class. One class from Year 7 (11-12 years), one class from Year 8 (12-13 years), two classes from Year 9 (13-14 years) and one class from

Year 10 (14-15 years) were studied. Transcripts of lessons were made following the completion of the problem-solving activity. These were analysed, in conjunction with the audiotapes, for evidence of reasoning activity, or ‘exploratory talk’. Episodes which represented evidence of shifts in conceptual understanding were identified.

## Findings

To place the following findings in context, I present an example of a transcript for a Year 9 (13-14 years) group of five girls, recorded during the first of seven lessons investigating the logarithmic scale through an open-ended activity. This episode is taken at approximately 30 minutes from the start of their work during which they have generated some data. At this point, the group is drawing on previous knowledge about patterns in differences between numbers and attempt to reconcile this knowledge with the evidence they have in their data.

**S** Maybe it’s because, you know, the differences are getting smaller, maybe they’ve got so small they’re actually the same
**K** Yeah, I know that
**S** Do you know what I mean ... cos here the differences ...
**K** S ...
**S** … between 16 and 16 .. 32 ... ahhhh .. hang on, that’s 16, 16, 32, that repeats itself and then you’ve got another table 48 and 64, what do they belong to?
**C** They’re all times 8
**S** 6 times 8, yeah?
**K** Hey, hang on S. I say, S. Put a star by the repeat pattern of 16 and 32, cos they’re coming up mostly every column, and every C number, do you get what I mean, every C section they’re coming in. I’m just going to put a star by some of the C numbers
[shuffling for 20 seconds]
**K** S, S, listen
**C** shhhh [to the others]
**K** I just went through, yeah, and ...
**C** shhhh [to the others]
**K** Every C number which has got a 16 and a 32 in it, they come really close together
**S** Yeah
**K** Cos they’re next to each other, cos you know they’ve got a gap in between here ...
**S** Yeah
**K** You can work it out, do you know what I mean?
**S** Yeah, Yeah
**K** I think it’s because you half that number or you put double that one
**J** And plus she’s right
**S** She’s more right than anyone else
**P** OK, so if you had 48, that’s 24 .... then you’ve got C24
**S** I’ve got C24
**J** 458
**P** Oh yeah, they are actually
**K** See!
**C** It’s only because they’re getting so close together
**K** It’s not, its not, cos look,.....458 and C ... no, you haven’t got C23, so …

This episode appears to be mainly an interchange between **S** and **K**, but, in fact, all five group members are very much involved. The initiation made by **S** (lines 299-300) is first taken up by **K** and, during the discussion, there is a shift in influence between these two participants. **S**'s musings and questioning (lines 304-5) prompt **K** to follow her line of reasoning. She attempts to address **S** directly on several occasions (lines 303, 308, 313) and needs **C**'s support (lines 314 and 316) to gain the attention of the rest of the group who have lapsed into inaudible muttering. **S** accepts the direct address (indicated by the intervening acknowledgements to **K**) but the other three members in the group remain involved and supportive of **K**'s explanation. Both **P** and **J** indicate an acceptance of **K**'s explanation (lines 326, 328, 330 and 331). However, **C** provides a challenge to her explanation (line 333) and **K** attempts to justify her explanation by example. She finds that she is unable to do so because her evidence relies on having data for a prime number (not able to be generated). **C**'s reasoning may be moving her towards the idea of a mathematical limit.

All the groups studied demonstrated such evidence of exploratory talk, though to varying degrees. There was a direct relationship between the length of time groups had worked together and the amount of exploratory talk identified. Similarly, the length of time a group had experienced a sociocultural and emancipatory learning environment had a direct relationship to the amount of exploratory talk evident. The class which had experienced the pedagogy for the longest period of time (Year 10) demonstrated the highest levels of exploratory talk activity.

Some groups demonstrated a 'follow-on' means of connecting everyone's talk. The metaphor of a thread traced through this discussion comes to mind. This method served to keep everyone engaged with the task and perhaps served as a means of maintaining cognitive cohesion. Even groups which exhibited little exploratory talk during a lesson, had a 'way of working' together that was positive and evident in the way interactions occurred. For the Year 10 group (14-15 year olds), who had worked together for almost two years, findings indicate that a 'way of working' based on co-constructed 'norms' had evolved. This enabled each member to function in an atmosphere of trust and a familiarity of 'unwritten rules'. Similar patterns emerged in different ways for different groups.

A Year 9 group (13-14 year olds) used strategies of 'holding back, supporting affective or emotional aspects of learning and an acceptance of 'talking aloud' as a 'way of working'. Another Year 9 group demonstrated 'polite turn-taking' as a means of working together. The variation in modes of developing what Yackel (1995) calls "sociomathematical norms" reflects the variety of ways each group used to engage with mathematics learning and the subsequent maintenance of the group's progress in this.

Much of the research on peer interaction in small groups has focused on giving and receiving explanations in relation to student achievement. Webb (1991) provides a review of such studies, some of the findings of which are supported by the analysis of episodes in this study. One of the less productive classes, in terms of developing exploratory talk, is the Year 7 class (11-12 year olds). In one episode, a peer tutoring relationship develops between two students in which one student gave answers without explanation. Webb (*op cit*) found that received help was most effective when accompanied by an elaborated explanation rather than just a given answer. The existence of such peer tutoring relationships in some groups may limit the opportunities for exploratory talk to develop between members of a group. In contrast, other groups elaborated constructively on their explanations, generating an improved cognitive learning environment. However, Webb's description of elaborated explanations does not encompass the socially constructed knowledge evident in the episodes in this study. This further highlights the differences between Webb's review of cooperative learning and the *collaborative* learning explored in this study and raises questions about the difference between action-performance outcomes in cooperative group studies and interaction-cognitive development outcomes in collaborative group studies.

In an analysis of talk within small groups in a Year 10 class solving closed problems related to finding the equation of a graph, Barnes (1999) identified exploratory talk in the transcripts. She was observing students working on closed, closely defined problems and it is not made clear whether the learning environment was sociocultural. The lesson fitted a more traditional model of teacher exposition followed by student activity during which students were expected to work in small groups on the assigned problems. This situation contrasts with the study described here in which problem-solving groups are the normal mode of working and learning. The lack of commonality between the categorisation of particular episodes of talk as 'exploratory' in Barnes' study and that described here may support Cohen's (*op cit*) findings. She identified the need for interactions amongst group members to be more critical with a more mutual exchange of ideas and speculations if *conceptual* learning is to take place. In the episodes analysed in the study reported here, the conceptual shifts are evident in some of the exploratory talk described and indicate a higher level of reasoned thinking than that described by Barnes (*op cit*). This may be directly related to the difference in openness of the respective tasks and the consequent opportunities offered for conceptual learning. However, another factor is the familiarity of group members with group work as a mediator for learning and, more specifically, in a sociocultural learning environment. This comparative evidence is not available in the description of Barnes' study.

## Discussion

Sociocultural models of learning are promoted through collaborative groups, the use of open-ended activities for learning situations and an encouragement of active participation in learning. Emancipatory practice is identified in the decentralisation of the mathematical authority in the classroom and the restructuring of power relations. The longer the experience of these modes of learning and the longer the students work as a group, the greater the authority students have over their learning. Episodes of 'exploratory talk' in this study provide evidence that cognitive growth can happen within collaborative groups without the presence of a ‘more learned other’. This raises questions about the model which necessitates such a person in the learning context and how this is reflected amongst group members.

One of the factors in this study which separates it from almost all other studies of small group work in mathematics education is the study of self-selecting groups on the basis of friendship. I propose that this factor impinges on other factors already discussed – length of time engaged with the pedagogy, length of time working together and establishing sociomathematical ‘ways of working’. The findings in this study support those of Zarjac and Hartup (1997) who found that friends were better co-learners than non-friends. They suggest reasons for this include the fact that knowing each other well means that they know their similarities and differences, so suggestions, explanations and criticisms are more likely to be more appropriately directed. Their mutual commitment generates particular expectations which support collaborative means of working. They feel more secure with friends so become more active in novel problem-solving situations.

This sense of trust is also supported by Wegerif (*op cit*) who claims that trust can be conceptualised as a prop for cognitive development. Being able to trust others facilitates being able to take the risks involved in learning new concepts. These findings and those from the study reported here contradict other evidence which suggests that group composition needs to be altered regularly for effective working relationships. The findings also support evidence that group members do not like having membership of a group pre-assigned by others.

Forman and Cazden (1985) found that partners can require several sessions to develop an effective problem solving style. Forman and McPhail (*op cit*) highlighted the need for students to develop joint perspectives over time to achieve shared goals and Laborde (1994) found that one of the factors of effective small group learning was the time the members of the group had worked together. Friendship groupings appear to negate the necessity for teaching group skills and accelerate the rate at which effective reasoning can develop.

A feature common to all the groups studied is the extent to which group members ‘talk aloud’. There may be many reasons for this. One possible reason is that it acts as another level of cohesion for the group, enabling thinking to become public knowledge so that the group’s *thinking* is bound together. If so, it may be evidence for shared cognition in which knowledge is co-constructed through socially shared images, experiences, and, in this case, acts. Gooding and Stacey (*op cit*) similarly found more heightened levels of ‘talking aloud’ than other studies on small group interactions. They suggest reasons for this may include the level of difficulty of the task. More difficult tasks generate a higher level of ‘talking aloud’ (which they term ‘thinking aloud’).

If Vygotsky’s model of a ‘zone of proximal development’ is to accommodate the evidence from this study, it needs to be redefined as a social space as well as a cognitive space. This social space would encompass the learning environment, the specific learning context (the task), the affective and emotive attributes of learning and the dialogic (Wegerif *op cit*) which binds them together in socially constructed knowledge. Friendship groups, in particular, support dialogical reasoning, which is based on differences and challenge, because of the assumed level of trust among participants. Friendship groups also explain high levels of 'exploratory talk' in which participants question, hypothesise, challenge, explain and justify because the assumed basis of this type of talk is the complete acceptance of the offered statement in the spirit of moving thinking and learning forward.

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