Patterns of Participation in Small-Group Collaborative Work

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This paper reports an investigation of collaborative learning in mathematics classes that sought to identify patterns of participation in small-group activities. Videotapes of lessons in three senior mathematics classes were studied, and, using positioning theory, a range of subject positions available to students during small-group collaborative activities was determined. A student's pattern of participation was defined as the combination of positions regularly taken up by that student, and groups of students with common patterns of participation were identified. Implications for collaborative learning are discussed.

This paper is a report of an investigation of senior mathematics students' experiences of collaborative learning. By *collaborative learning* I mean forms of classroom organisation in which students work in small groups on relatively open-ended tasks, constructing shared understandings through a process of discussion and negotiation. It has been argued that social processes involving the negotiation of meaning play a key role in the learning of mathematics (Cobb & Bauersfeld, 1995), and that creating a community of learners (Brown, 1994) leads to better understanding of complex ideas. Recent curriculum documents emphasising the communication of mathematical ideas within a challenging and supportive environment (Australian Education Council, 1991; National Council of Teachers of Mathematics, 2000) provide support for collaborative learning.

Much research on group processes in the classroom, including collaborative learning, has focussed on outcomes (Springer, Stanne, & Donovan, 1999; Suri, 1997; Webb & Palincsar, 1996) including social, emotional, and attitudinal as well as cognitive outcomes. Although the verdict has generally been positive, some researchers (Noddings, 1989; Stacey, 1992) have pointed to potential problems with some forms of peer learning. More recent research in mathematics education has focussed on the interactions among students when collaborating, especially the cognitive processes involved (e.g., Goos, 1997; 1998; Goos, 2000; Williams, 2000), although Cohen (1994) and Watson and Chick (2001) took both cognitive and social factors into account. Cohen stressed the importance of status, influenced by factors such as gender, race and social class as well as perceived ability, and Watson and Chick introduced the idea of the "charismatic intellectual" with both cognitive and leadership ability who had a major influence on group outcomes. This paper builds on that idea by seeking to identify common patterns of participation of students in collaborative groups.

Theoretical Framework

Positioning theory provides a theoretical framework for investigating the dynamics of social interactions. Linehan and McCarthy (2000, p. 441) describe positioning theory as "an analytic tool that can be used flexibly to describe the shifting multiple relations in a community of practice". This makes it particularly appropriate for analysing the complex interactions within a group of students engaged in collaborative learning activities.

Positioning theory is based on social constructionism, and draws on Vygotsky's ideas about the cultural imbeddedness of thought and language, and on Wittgenstein's concept of language games (Howie & Peters, 1996). It assumes that human behaviour is goal-directed and constrained by group norms, and that human subjectivity is a product of the history of each individual's interactions with other people (Harré & van Langenhove, 1999). Harré and his colleagues (see, for example, Davies & Harré, 1990; Harré & van Langenhove, 1999) argue that during conversational interactions, people can be thought of as presenting themselves and others as actors in a drama, with different parts or "positions" assigned to the various participants. The positions are not fixed, but fluid, and may change from one moment to another during an interaction, depending on the storylines through which the participants make meaning of the interaction. Participants may actively seek to adopt a position, or may be assigned to it by others. If a position is assigned to them, they may acquiesce in this, contest it or subvert it (Harré & van Langenhove, 1999). A particular position may carry expectations about how one ought to behave, constraints on what one may meaningfully say or do, and also rights, such as the right to be heard.

An example illustrates the distinction between *positions* and *roles*: Within a school, both teachers and pupils have recognised rights and duties, constituting the reciprocal system of obligations that Brousseau (1986) called the "didactic contract". Here, *teacher* and *pupil* are not positions, but roles—long-term, not easily relinquished, and with a profound influence on the lives of those who occupy them. But during a classroom episode in which two students are working together, one may briefly take up a position as "teacher" with the other as "pupil". The "teacher" may, for example, assume a right to explain, give instructions, ask questions and evaluate answers. If the second student acquiesces in the positioning, she or he implicitly acknowledges an obligation to listen to the explanations, follow the instructions and answer the questions. In the process, the two jointly construct a 'teacher helping pupil' storyline. On the other hand, the "pupil" may resist being assigned to this position, either tacitly, for example by arguing about the content of the explanation and thereby implicitly claiming superior knowledge, or explicitly, by saying something like "What makes you think you know better?" Or the pupil may subvert the process by changing the storyline, for example by initiating off-task talk or play, and in this way change the available positions and the associated system of rights and duties.

Linehan and McCarthy (2000, p. 442) explain that "both students and teachers have a degree of agency in how they position themselves in interactions but this agency is interlaced with the expectations and history of the community". For a mathematics classroom using a collaborative learning approach, the expectations and history include behavioural norms for small-group work which the teacher has negotiated with the class, such as a duty to listen attentively to what other group members have to say, and an obligation to justify any assertions made. There are no general rules that can be applied to make sense of a social interaction such as a small group discussion. Rather, the verbal and non-verbal behaviour of the participants must be interpreted in the light of specific details of what is said and done and how others respond, taking into consideration the context, the history of the interaction, and the norms and values of the community in which it takes place. To identify positionings it is necessary to look at the detail of each interaction, and

make inferences about the rights and duties that are being presumed by the participants. Subsequent interviews with the participants can help, by uncovering the storylines, as well as personal memories, goals and values.

Methodology

Three classes were selected for a multi-site case study by a process of purposive sampling. All classes were coeducational, and all were studying introductory calculus when observed. The teachers were experienced in using peer collaboration methods. Subject to these constraints, as much variety as possible was incorporated. The sample was drawn from metropolitan and rural areas, and included government and independent schools, small and large classes, male and female teachers, and varied ethnic and social class backgrounds.

To investigate student-student interactions during collaborative learning, lessons were videotaped, making it possible to return to the video to check interpretations as often as needed. During small-group discussions, the camera focussed on one group and speech was captured by a desk microphone. Additional data included interviews with selected students and teachers, field notes, worksheets, and copies of student written work. To provide sufficiently prolonged engagement, each class was observed for two periods of two to three weeks each, with a gap between them to allow for reflection and preliminary analysis.

Analysis

Analysis focussed on the small-group discussion segments of the videotaped lessons, and proceeded by stages, from an in-depth study of a single lesson, to a slightly less-detailed analysis of a further nine lessons, and then an overview of all remaining lessons.

The analysis of the first lesson focussed on the flow of ideas and the enactment of power. Each idea introduced in the discussion was traced throughout the lesson, noting who first mentioned it, whether it was adopted or abandoned, who supported or rejected it, whether it recurred later in the lesson, and who reintroduced it. This showed that the adoption of an idea had less to do with its usefulness or even its correctness than with who proposed or supported it. This analysis enabled the identification of a range of ways in which students positioned themselves, or were positioned by others, during the discussion. A list was prepared, describing empirically-observed behaviours for each position, and the rights and duties inferred from observation of the interactions.

Excerpts from nine further lessons were then selected for detailed study. At this stage I looked for evidence of positions not so far described, and sought to elaborate descriptions of positions already identified. By the end of the process, a total of fourteen different positions had been identified. These are listed in Table 1, with a brief description of each.

Table 1
List of Identified Positions With Descriptive Indicators

Position	Indicators
Manager	Initiates work, invites ideas, interprets instructions, gives orders or makes suggestions about who should do what, or how they should tackle the task.

Position	Indicators
Expert	Makes authoritative mathematical statements, and decides what is correct; Or is asked for help by others who accept the answers as authoritative.
Spokesperson	Speaks to the teacher on behalf of the group, to explain what they have done, to clarify what is wanted, or to ask if they are "right".
Facilitator	Acts to keep the group functioning smoothly, gives social support, ensures that nobody is ignored, tries to avoid or resolve conflict.
Critic	Seeks explanations, looks for alternative methods, disputes other people's assertions. May point out flaws in reasoning or inaccuracies in calculations.
Collaborator	Works closely with others, uses collaborative forms of talk, like speaking in chorus or completing another's sentences, engages actively in discussion.
Outside Expert	Introduces specialised expertise (from outside the classroom), and uses it to give examples, contextualise the task. Expertise is acknowledged by others.
Helper	Carries out routine tasks on behalf of another group member, usually a Manager. Acts in a subordinate position, under the other person's direction.
In Need of Help	Either claims not to understand, and explicitly or implicitly asks for help; or accepts an offer of help from another and attends to the explanation.
Humorist	Makes an amusing comment, gesture or facial expression—but it is brief, is related to the group's activity, and does not distract significantly from it.
Entertainer	Initiates and sustains off-task activity—talk, gossip, banter, singing, or play, causing a significant distraction from the group's work.
Audience	Is willing to be amused by an Entertainer. May contribute to the conversation initiated by the Entertainer or join in activities.
Networker	Monitors events in other parts of the room, or listens to the talk in other groups. Joins in mathematical talk or off-task activity with other groups.
Outsider	Either tries to join in the discussion, but is frequently interrupted or ignored; or says nothing for a long time, and gives no sign of seeking to participate.

In the next stage, these descriptions of positions were applied to the remaining lessons. This was done directly from the video record, and not from a transcript, so that facial expressions, body language, and other contextual cues could be taken into account along with what was said. Analysis of lessons from the third school revealed no new positions, indicating that theoretical saturation had probably been attained.

The results of the analysis of all lessons were then tabulated. The tables showed the positions occupied at different times during the lesson by each student in the research focus group, and noted whether the position was assumed by the student or assigned by others, and whether it was occupied only briefly, or either frequently or for a sustained period of time.

By comparing how students were positioned across several lessons, and relating this to field notes and interviews, it was possible to identify for each student a cluster of positions that represented their typical pattern of participation in collaborative activities. Once the analysis of positioning in all the recorded lessons was complete, it became possible not

only to identify typical patterns for individual students, but, by looking across all three schools, to look for common patterns of participation shared by groups of students.

The tables represented summaries of observations, so did not tell the full story, but they strongly indicated groups of students with similar patterns of behaviour. Information from the tables was interpreted in the light of the video records and interviews. Departures from an apparent pattern could often be explained by taking into account the composition of the group or the nature of the task on that particular occasion. Where available, the students' own accounts of their attitudes to mathematics and to collaborative work and of their approaches to learning mathematics helped to explain their observed behaviour.

Results

Five main patterns of participation were identified. Four were found in all three schools and the other in two schools. Nearly all students who had been observed at least twice fitted one of these patterns. A few who had been observed only once were also classified, if there was additional information to suggest that the pattern observed on that occasion was reasonably typical. This left a small number of special cases to be considered individually.

Single-Minded Intellectuals

Students in one clearly identifiable group were nearly always positioned as Expert, and often as Manager and Spokesperson, but rarely took up any other position. I call them *Single-Minded Intellectuals*. They were task-focussed, and mostly ignored distractions. They did not collaborate well, seeming unwilling to listen to other people's ideas.

They were confident in their own mathematical capability, but the fact that they were regularly able to position themselves as Experts suggests that other students respected their abilities too. Nevertheless, they all had some difficulty in relating to their peers. Interview responses indicated that they did not greatly value explaining to others, found explaining difficult, and sometimes felt impatient when the others failed to understand. Instead of collaborating, they often worked alone, and announced their ideas or answers to the rest of the group afterwards. When asked if they would prefer to tackle a challenging problem alone or in a group, they were among the very small number of those interviewed who said that, at first, they would rather tackle it on their own. I gained a clear sense that they gained self-affirmation from knowing that they could solve a difficult problem by themselves. They were competitive, persistent, and sometimes came across as arrogant.

Interactive Leaders

The participation patterns of another group of students can best be described as characterised by fluidity of positioning. I call them *Interactive Leaders*, because they were frequently positioned as Managers and Collaborators, but they also fairly regularly took up positions as Facilitators, Helpers, Spokespersons, Experts and Critics.

The Interactive Leaders were willing to accept responsibility. Some were high-achievers in mathematics, but certainly not all. Nevertheless, they all engaged with the mathematics, worked hard and did whatever the teacher expected of them. They communicated easily with others in their groups, and showed themselves ready to encourage or empathise with them. All those interviewed spoke positively about collaborative work and said they would

rather tackle a challenging problem in a group than on their own. While the Single-Minded Intellectuals talked about collaboration in terms of explaining their ideas to others (and their difficulties in doing so), the Interactive Leaders spoke of combining or sharing ideas and learning new ways to approach a problem. The consensus was that they liked the challenge of mathematics and really liked finding out how other people thought.

Responsive Intellectuals

Another group of students combined aspects of the two groups already described. They regularly took positions as Experts, but were Collaborators, Critics, Managers, and Spokespersons more often than the Single-Minded Intellectuals, and Collaborators less often than the Interactive Leaders. Because they spoke with authority but also listened and responded to other people, I call them *Responsive Intellectuals.*

Unlike the Single-minded Intellectuals, there was little evidence that these students had difficulties in communicating. They were confident, but did not appear arrogant. Their relationships with their peers were generally good, although less egalitarian than those of the Interactive Leaders. They were recognised as capable in mathematics, and as a result other students tended to defer to their opinions. Where the Single-Minded Intellectuals mostly ignored other people's suggestions and insisted their own ideas were correct, the Responsive Intellectuals were willing to listen, admit uncertainty, and at times ask for help.

They were thoughtful about leadership issues. Kofe claimed that "Every group needs a leader, so you know where you're going", and talked about how to include everybody in the discussion without making anyone feel they were being put on the spot, while Sally described the frustrations of trying to get everyone to participate "when two or three people in your group decide they're not going to do anything".

Attention-Seekers

One group frequently took up positions as Entertainer, Networker, or Humorist and also as Manager, Spokesperson or Expert, but never as Facilitator, Collaborator, or Helper. Whatever the activity, these students made themselves the focus of attention of either their own group, the teacher, or other groups. I call them *Dominant Attention-Seekers*. They were often responsible for distracting other students (in their own or other groups) from the assigned task by engaging in talk, banter, or various forms of play. Within a group, they regularly attempted to take up high-status positions like Manager or Expert that allowed them to exert influence, but other students sometimes resisted this. As Spokespersons, they often called out to attract the teacher's attention. They appeared competitive, self-centred, and inattentive to others' needs. They often sought opportunities to report on behalf of their group, and when they did report, appeared to enjoy the attention greatly.

Several other students fitted the Attention-Seeker pattern, in that they often took up positions as Humorists, Entertainers, or Networkers, but they were more often positioned as Collaborators than the Dominant Attention-Seekers, and less consistently sought to occupy influential positions such as Manager, Spokesperson or Expert. I call them *Collaborative Attention-Seekers*. They and the Dominant Attention-Seekers belonged to the same friendship groups, and peer pressure seemed to be an important factor in their

behaviour. During group work, they maintained contact and introduced friendly inter-group rivalry. They generally enlivened lessons and initiated most of the classroom humour.

Attention-Avoiders

The next group, *Attention-Avoiders*, could be described as keeping a low profile, and were almost direct opposites of the Attention-Seekers. They often took up positions as Facilitators, Collaborators and Helpers, and sometimes as Humorists, but rarely occupied positions where they could influence or distract others. They seemed very willing to participate, but did nothing to attract the attention of the teacher or the rest of the class, and tried to avoid being chosen to report on behalf of their group. They expressed a lack of confidence, talked about getting confused easily, or claimed that they were not particularly strong in maths. They thought that working in groups was helpful, but mainly mentioned situations when other people helped them by explaining things they didn't understand. For example, Grace said "I'm not particularly strong at maths … groups made it easier to say 'I don't understand'." and Dalin "there's some things that I don't know and they like help me to understand it." They also reported feeling annoyed when other people raced ahead during group work and refused to stop to explain. They felt that they needed time to sort things out, and hated feeling under pressure or being left behind.

Additional Patterns

A small number of additional cases needed to be considered separately, and are not discussed in detail here. One involved just two girls, whom I call *Helpless Females*. They regularly took up positions as In Need of Help, and persuaded other students to tell them what to do or to do the work for them. They were also very sociable, and frequently introduced off-task talk and gossip. Also requiring special consideration were the few students positioned as *Outsiders* who were frequently ignored or interrupted. And finally there were three whose participation differed markedly depending on the composition of the group they were in, or the nature of the task. These last provide a reminder of the importance of the context of the interaction in determining patterns of participation.

Discussion

Although student learning outcomes were not the focus of this study, a major premise, for which there is extensive research evidence, is that student learning is optimally promoted by deep engagement during student-student interaction which has mathematics as its explicit content. Identifying patterns of participation is a step towards developing a better understanding of factors that promote or inhibit effective collaboration.

The participation patterns exhibited by the Interactive Leaders and the Responsive Intellectuals were productive, generally supporting effective group interaction. Indeed, the Responsive Intellectuals closely resembled the "Charismatic Intellectuals" described by Watson and Chick (2001). By contrast, the Single-Minded Intellectuals had a dysfunctional participation pattern. Their focus on solving the problem rather than sharing ideas meant that although some members of the group might reach a solution to the assigned problem, the discussion was often ineffective, with others left confused. The Attention-Seekers had an even more dysfunctional pattern. They were strong (often autocratic) leaders, but often

lacked sufficient intellectual skills, so tended either to lead the group astray or distract them completely from the task by networking or entertainment.

This research underlines the importance of understanding power relations. For example, the Attention-Seekers had considerable social power, but used it to the detriment of their own and their peers' learning, while the Collaborative Leaders used their social power to help their groups function effectively. The Attention-Avoiders were relatively powerless.

Because of time limitations, the analysis in this study focussed only on the small-group discussion portions of the lessons. Whole-class reporting and discussion were not analysed, although they are a key aspect of collaborative learning. The expectation that every student will be able to report on her or his group's work helps to ensure individual accountability, and whole-class discussions enable solutions to be evaluated, work done in the separate groups consolidated, and new ideas linked to existing understandings. Further research is thus needed to investigate patterns of participation in whole-class discussions.

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