Cooperative Learning Environments

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Learning is a social activity but mathematics classrooms are often sites for solitary work or at best, parallel work where students may sit in groups but do not interact. For the engagement of learners, working collaboratively in mathematics represents a significant shift in practice. This paper explores the principles of cooperative learning environments ad with the roles that learners need to undertake to ensure group participation and membership. Working in Indigenous environments, there are considerable challenges to implementing a collaborative learning environment despite its synergies with Indigenous ways of knowing.

Initially the *Maths in the Kimberley* (MITK) project drew on Complex Instruction (Cohen & Latan, 1997) processes as outlined through Boaler's (2008) work with Railside. In this reform approach to mathematics, group work was seen as a key feature of the learning environment. At Railside, Boaler found that group work, when accompanied by well designed tasks, fostered deep learning among students. The quality interactions among learners in groups as they worked collaboratively on well-designed tasks facilitated deep learning. In this approach, group work was structured so as to enable learners to talk, debate, contest, clarify, etc their understandings as they engaged with mathematical tasks that were cognitively demanding. These two constructs were central to engaging learners in mathematics. As will be discussed in Richard Niesche's paper in this symposium, quality tasks are central to the learning as they provide the entrée into the mathematics while enabling good discussion among peers. The ideas that Niesche also proposes are critical to the language backgrounds of the learners and how they can use home language to negotiate meanings in group work. The culmination of learning through engagement in group work, with shared responsibility for reporting back is discussed in Sullivan's paper. Collectively, these elements of the Kimberley Mathematics project are outlined in this symposium.

Within the Complex Instruction model, students are expected to act as resources for each other within a group. Cohen and Latan (1997) state the fundamental premise of the grouped activity work is that students "have the right to ask for help, and you have the duty to assist when asked" (p.21). This approach encourages students to justify their arguments; explain their processes or rationales for actions; seek clarification for action and so on. This encourages the development of rich thinking among students.

Cooperative Learning and Indigenous Education

The use of cooperative learning appears to be a useful strategy, at least at a theoretical level, when working with Indigenous learners. As cultures that rely on oral traditions, being able to talk with peers would seem to resonate with these cultures. However, as has been noted in earlier research there are often expectations held about the teaching of mathematics that are held by learners of particular cultures. Mathematics is frequently seen as a curriculum area where individual learning is the norm so shifting this approach to one of collaboration demands a shift in culture that needs to be made explicit to learners so that they can understand and engage with the changed environment. It would appear that collaborative learning augers well with many Indigenous ways of knowing and working.

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Constitution of Groups

Drawing on heterogeneous grouping research, within the approach there is a strong recognition that groups should be multi-ability. This approach represents the usual practices beyond school. In out-of-school settings, there is a broad range of skills, strengths, dispositions in most workplaces that collectively enable the successful completion of problems or tasks. Similarly, ensuring a diversity of strengths within a group enables a more comprehensive team that is more likely to be able to solve the problems/tasks being posed. Studies have consistently shown that heterogeneous grouping benefits all learners so that mixing students offers greater potential for learning than homogeneous groupings. However, Gillies and Ashman (1995) argue that for the most gain from heterogeneous grouping, students need to be skilled in interpersonal skills and know how to work in groups.

Gillies (2005) summarises collaborative group work as being most effective when the size of the group is around 4 members; where there is a gender balance and a mix of abilities; where tasks are clearly defined (such as open and discovery based as found in the rich-task format) and with explicit criteria and scaffolding; and where students receive appropriate training/scaffolding to provide and ask for assistance.

Group Task

It is not the intention to elucidate on this aspect of group work in this paper as it will be addressed in greater detail by Grootenboer in this selection of papers. However, it is worthy to note that most mathematics tasks given to students, such as find the area of a particular shape, only require minimal interaction among peers. These tasks are often clearly outlined, have a well defined process for resolution; have a clear prescription in process and produce and in so doing have little need for interaction among peers. With this in mind, the effectiveness of collaborative learning is highly contingent upon the provision of good tasks that enable dialogue among peers.

Maximising Participation in Small Groups

To ensure that students gain most learning, the teacher needs to ensure maximum participation in small groups. This is achieved by the teacher delegating authority to students so that the teacher is able to monitor classroom behaviour by making students responsible for their own and their peers' learning. Students are expected to monitor their own on-task behaviour as well as their peers.

The students assume responsibility within the group to support each other. Gillies (2005, p. 107) referred to the concept of 'promotive interaction' which she argued enabled student to provide support to each other; facilitated the sharing of resources; providing constructive feedback to peers in order to enhance performance on a task; provoke challenges to the conclusions provided by groups in order to gain improved insights into the tasks and solutions; enabled students to encourage the engagement of their peers; demonstrating positive dispositions towards peers; and for mutual gains for all participants.

Roles within Cooperative Learning

In the traditional group work models, particular roles have been identified such as reporter, gopher, time keeper, and material manager processes. These traditional roles tend to allow learners to take on particular roles but where there is no interdependence among members. For example, the time keeper can keep an eye on the time but not engage in the

substantive learning. As such, those roles can foster more opting out of the learning than engaging with the learning. In contrast the roles advocated in the Complex Instruction model are ones where students are encouraged to be proactive in the learning process. For example, one person may be assigned encourager where the role is to listen to the contribution of members and where a member makes a contribution to the discussion but this may be ignored or skipped over, the encourager brings the discussion around to include this contribution. Some of the specific roles that Cohen and Latan (1997) identify are:

Facilitator: ensures that all members understand the instructions and expectations of the task; that all students have opportunities to participate in activities and discussion; and acts as the conduit between the teacher and group members

Reporter: undertakes the reporting back on the learning of the group; and often evaluates how the group worked.

Materials manager: ensures all equipment is collected for the activities; oversees any tidy up at the end of the lesson

Harmonizer: facilitates communication among the group; encourages students to participate (or not participate if someone dominates).

McInerney & McInerney (1998) also advocate for similar roles to Cohen and Latan but extend this to include:

Motivator: to ensure the group moves with the tasks

Contributor: ensures that self makes a contribution and models this to other members so as to ensure all members contribute

Summariser: keeps a record of key points raised by the group to enable a recapitulation at the end of the activity

Collectively this range of roles ensures that the group self-monitors as they work through the tasks and keeps all members actively engaged with the task and its resolution

Group Accountability

Aligned strongly with the Chinese approach to education and learning, the approach adopted within this project is one where the group is accountable for the learning of others within that group. The Complex Instruction model has the students working within the group and when it appears that all members understand the underlying mathematics and could individually explain their learning to the teacher, the member responsible for the group, calls the teacher over. The teacher's role is now one of asking members to explain his/her learning or understandings. If a member does not appear to understand the expectations of the task, then the teacher passes responsibility back to the group, and walks away, leaving the group members to support their peer in coming to understand. The teacher may pose questions to provoke a learning episode but the responsibility remains with the group.

Teacher Roles

The approach requires the teacher to progressively remove him/herself from a direct teaching role. Initially time is spent on developing the classroom culture but as this becomes embedded, the teachers' role is less intrusive and becomes more engaging. Cohen and Latan's (1997) research indicates that at first this may be threatening to teachers to absolve responsibility for direct teaching but as the practices becomes more entrenched,

the role of the teacher shifts to a more enjoyable one where they are able to take a greater responsibility for fostering deep learning over behaviour management.

One of the most critical roles for the teacher is the assigning of status to students. As the role becomes more about observations of students, the teacher is able to observe students interactions. As a goal of the approach is to increase participation rates for all students, the teacher assumes responsibility for enabling the inclusion of students who are often peripheral to groups. This is achieved by assigning status to students who may not be included by peers. In her work, Boaler noted the teacher hearing student input but which was ignored by her peers so the teacher casually drew attention to the student's input thus making her input critical to the resolution of the task. This process assigned recognition (or status) to the student.

Enacting Collaboratively Learning in Remote Indigenous Communities

The rhetoric around collaborative learning through structured group work that has been centred on quality tasks suggests that there would be very positive gains – cognitively and socially. As noted, such a process is often quite different from the traditional approaches found in school mathematics – namely solitary and competitive work. As such, implementing this change requires considerable input and support from teachers as it represents a cultural shift in the classroom organisation.

Within the remote communities, working in small groups posed particular challenges in some schools. For small communities where the class size is often small, that is, where there may be less than 10 students in a class, and in some cases, only 4-6 students in a class, the small group is the class. Further compounding the small class size is the issue that many of the students are from the same family thus making for the group to be a family grouping with the dynamics from the family in operation. For the teachers, group work posed challenges that are not evident in larger classes. However, from a project perspective, we would contend that the principles of collaborative learning can be enacted within these small classes when the teacher is able to scaffold student learning of the principles that underpin this form of classroom organisation.

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