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Small-Group Learning In The Mathematics Classroom

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Abstract

This essay discusses the importance of small-group learning in the mathematics classroom by stating the activities that can be carried out so as to enhance students' learning of mathematics. The activities discussed involve the use of language, reflection, problem solving and investigation, problem posing and co-operative learning. Furthermore the activities mentioned are able to build rapport between the mathematics teacher and the students, and also among students themselves. Definitions of learning, types of small-group learning and the role of teachers in small-group learning are also discussed.

Introduction

"I wish the number of students in a classroom were smaller so that I would be able to know all their names!" This is a common expression of teachers, who wish for smaller classes so that teachers and students are able to interact and create mutual rapport. "Teachers have constantly argued for smaller class sizes for the weaker ... pupils but this does not seem to have received favourable support from their political masters" (Wong, 1991, p. 139). Big class sizes make it difficult to put students into small groups because of lack of space and also because there would be too many groups for the teacher to manage. Teachers always believe that students learn better in small groups as mentioned by Davidson (1990, p. 60) who states that

> *there are many advantages to learning mathematics in small, cooperative groups. Students are actively involved in learning mathematics while working at a comfortable pace. They learn to cooperate with others, to improve their social skills, and to communicate in the language of mathematics. Students tend to become friends with their group members across traditional boundaries of race, ethnicity, or sex. Many students maintain a high level of interest in the mathematical activities.*

Small-group learning is good for activities like discussion, problem solving, problem posing, reflection on own's work, and activities like games and puzzles. It also creates a co-operative learning environment. Some students are able to learn better in small groups because they are too afraid or shy to ask questions in front of the whole class.

This paper will explore learning in general, learning of mathematics, importance of small-group learning in the mathematics classroom and the role of teachers in such small-group settings. In order to understand better the purpose of small-group activity, the notion of what it means to learn will first be discussed.

Definitions of Learning

What is learning? Are students the only ones learning? Are adults learning? **Learning** is a process that is on-going throughout our lives. Even teachers are learning when they are teaching. Learning occurs when the learner finds a way to accommodate the new perspective or information (A National Statement on Mathematics for Australian Schools, 1990). According to Bell (1978) there are four phases of human learning which are apprehending, acquisition, storage and retrieval. He distinguished between eight types of learning, namely, signal learning, stimulus-response learning, chaining, verbal association, discrimination learning, concept learning, rule learning, and problem solving. These eight types of learning may be compared with four types of mathematical learning as suggested by Brown (1978) which are simple recall, algorithm learning, conceptual learning and problem solving (cited in Orton, 1993). It can be seen that mathematical learning and learning in general are similar.

I would like to look more into **mathematics learning** and the **learning environment** of students. Learning mathematics involves learning both its products and its processes, where the products (body of knowledge) are the facts, concepts, generalisations, standard models and procedures of mathematics and the processes (ways of knowing) are the mathematical thinking skills which enable the products to be developed, applied and communicated (A National Statement on Mathematics for Australian Schools, 1990). Orton (1993, p. 5) argues that "the learning environment might be an important factor in promoting the understanding of mathematics". I agree with Orton as I think that learning mathematics will be more effective if there are fewer students in a classroom as

this will enable discussion and hands-on mathematical activities to be carried out. The National Statement on Mathematics for Australian Schools (1990, p. 22) states that "a classroom learning environment encourages practical activity, the appropriate use of technology, and discussion".

Organisation of Small-Group Learning

There are various types of groups. Groups can consist of students of similar ability, mixed ability, mixed cultures, mixed gender, similar interests, mixed interests and mixed personalities. I believe that students will understand mathematics better when they learn in groups. Each group must be small, which is about 4 to 6 students. Rice (1992) suggests that groups can consist of pairs, threes or larger numbers of students and can be formed on the basis of like ability, mixed ability, friendship, gender, similar interests or personalities. Groups are usually formed by the teacher's instruction but groups do not work well when the students feel that they are forced to be together. However if the teacher gives the students the freedom to form their own groups, it is found that groups may be formed based on friendship which may lead to less popular students being omitted from a group. In this case the teacher can make suggestions as to groupings for all students. This is mentioned by Woodrow (1984) who also says that if pupils are allowed to associate freely in groups, they will often arrange themselves in like ability groups and it is very rare for a bright child to choose to work with a slower learner. The teacher could vary ways of grouping so that students would not get tired and bored of the same group and also the not so popular students would not feel rejected.

Dienes (1972, p. 65) believes that "working in groups needs a great deal of organising where each group needs to have a leader who is responsible for collecting the material for the work for each task". Each group should also include at least one "talker" who is willing to keep conversation flowing (Johnson, 1972). Thus grouping encourages discussion which will clarify students' understanding of certain concepts.

Importance of Small-Group Learning in the Mathematics Classroom

A classroom usually consists of 35 to 44 students. However, teachers prefer to have a smaller class size of about 25 students because they feel that it will be more manageable to carry out activities like problem solving, investigation and discussion. To help the weaker students, teachers always have to meet these students outside school curriculum time in small groups. These groups are usually weaker students who are asked by the teachers to see them or who go to see the teachers voluntarily. Small group learning in class is rarely carried out also because of the time imposed by the school timetable. Thus learning is mostly based on the teacher using the chalk and talk method of teaching. Even using this method, students of better home background have done well in mathematics because there is an association of higher socio-economic status with higher achievement (Cheung & Chong, 1993). The question to be asked is "Do good results in examination produced by students mean that they understand and are able to apply mathematical ideas?" Not necessarily so. Fuji (1993, p. 85) says that "even though Japanese students have high achievement scores in mathematics, they tended to have negative attitudes about mathematics which originated in everyday activities in mathematics classes in Japan". Fuji argues that this is because Japanese students learn mathematics by rote-learning involving many rules and formulae.

Small-group learning is important in the mathematics classroom as it enables students to discuss mathematical activities such as problem solving, problem posing, games and puzzles. Students are also able to reflect on their work. Lowe (1988) points out that group work supports the greater involvement of the majority of girls and others who have lacked success in previous competitive situations. Girls are not as outspoken as boys to give their opinions especially in a big class. According to Lowe they are readier and feel more comfortable to voice their opinions or ask questions in a small group. Furthermore, students are able to socialize with other students in the class by group interaction. Such social interaction helps students develop cooperative skills.

Discussion and language

In small-group learning, **discussion** is an activity that can be carried out. Wilen (1990) believes that class discussion is capable of promoting critical thinking, engagement in productive social interaction, and the assumption of

responsibility of self-instruction (cited in Bell, 1993). Discussion needs the use of language. **Language** is important in the learning of mathematics because it allows interaction. Woodrow (1984, p. 94) states that "if the number of pupils per group is fairly small it allows pupil-pupil interaction at a meaningful level, especially in situations where the pupils are given a common project to develop as a group". Lowe (1988, p. 205) states that "group work develops concept learning through increased use of language". This is further supported by Cockcroft (1982, cited in Thomas, 1994, p. 319) who states that

> *language plays an essential part in the formation and expression of mathematical ideas. School children should be encouraged to discuss and explain the mathematics that they are doing.*

Reflection

Reflection is an activity that is seldom carried out in a mathematics classroom because teachers and students are always concerned with getting the correct answers for mathematics questions. It enables students to think about the processes of what they had done, for example in problem solving. They could reflect on different ways of solving the problem and also, if they fail to solve it, on what they could have done. In groups, students will be able to reflect on what they had done by talking about it. Buxton (1981, p. 83) states that "*reflection* is the way in which we learn and it has enabled students to advance at a much greater speed".

Mathematical activities (for example Games and Puzzles)

Woodrow (1984) points out that class groups are formed after the introduction of an idea or activity to the whole class. He says that this enables a group of more able pupils to be given enrichment activities whilst most pupils are jointly practising new skills and ideas and the teacher can concentrate on a group of less able pupils. Mathematics can also be learnt through games and puzzles and this is best done in groups. Dunford (1984, p. 154) believes that "the inclusion of a *game, puzzle* or *recreation* must brighten the lesson and help the pupils". He feels that games can also be used to help in the teaching of many topics such as the four rules of number, co-ordinate vectors, fractions, angles and bearings.

Problem solving and investigations

Problem solving which is an important mathematical skill is best done in groups. This is supported by Hawton (1992) who believes that if students are given the opportunity to solve the same problems, the reluctant student is able to share the responsibility for success or failure and the range of past experiences is broadened as each student brings different knowledge and understandings to the task. In the National Statement on Mathematics for Australian Schools (1990, p. 40) it is stated that "asking children to talk about how they solved problems should help them to learn from each other and they will realise that there is often more than one way to deal with a situation". Holton (1994, p. 24) also states that "different people bring different experiences to bear and so the problem is considered from a number of perspectives".

Problem posing

Group work not only enables students to work together to solve problems but also enables them to pose problems to their peers. This activity is called **problem posing**. Silver (1994, p. 19) defines problem posing as "the generation of new problems and the reformulation of given problems". Problem posing is an important mathematical activity which could help the students to learn mathematics better.

Co-operative learning

Working in groups will create a co-operative learning environment. **Co-operative learning** is when children work and learn from each other, each member's contribution being accepted and valued and where children share responsibility for each product (McGennisken & Hay, 1988). Clements (1988, p. 78) states that "group *co-operative learning* is particularly successful with problem solving activities where children discuss, share ideas and solve the problem in a number of different ways". Davidson (1990) suggests that small-group co-operative learning can be used to foster effective mathematical communication, problem solving, logical reasoning, and the making of mathematical connections. Co-operative learning also benefits certain students, particularly girls (Stanic & Reys, 1987). Girls are not as outspoken as boys and they would not like to embarrass themselves in front of the whole class by asking "stupid" questions.

However in small groups, they would not feel shy to voice their opinions especially if they are comfortable with the group.

Role of Teachers in Small-Group Learning in the Mathematics Classroom

As pointed out by Lerman (1993, p. 61) "the teacher plays a major part in creating the environment in which children can best learn mathematics". Maier (1991, p. 66) contends that "the role of the teacher is to bring mathematical questions to the attention of children, encouraging them to seek answers, and to talk with them about possible solutions while allowing them to grope, err and discover for themselves". Mathematics teachers could show enthusiasm for teaching and learning mathematics to the students so as to enhance students' learning of mathematics. Travers, Pikaart, Suydam & Runion (1977, p. 189) state that "enthusiasm can also be conveyed by the concern which teachers express for their students' academic progress and this concern can be shown through individual conferences, through group discussions, or in written comments on homework and test papers".

In small-group learning, teachers are able to spend more time with the students and this creates rapport with each other. In this way, teachers are able to know students' difficulty in learning and thus may be able to help them to overcome this. In small-group learning, the teacher "consults with individuals, identifies learning difficulties, makes and modifies assignments, and in general facilitates the learning climate" (Travers, Pikaart, Suydam & Runion, 1977, p. 246).

Conclusion

When teaching mathematics, teachers need to establish whether their students can understand what they are teaching, whether they have any difficulties and whether they are paying attention to the lesson even though they seem to be. Many students are afraid to ask questions when they are in a big class because they think that the other students do not have the same problems as they do. However if the class is smaller in size and if there are small groups of four to six students, they will tend to discuss their problems and then discuss them with the teacher. Davidson (1990, p. 56) thinks that "it is necessary to form work groups of small size, since the opportunity for active participation decreases as the group size

increases". Problem solving and problem posing are activities which are best done in groups because they involve discussion and thus students will interact better.

Small-group learning is important because it improves peer relationships, builds acceptance of differences and leads students to support one another (Lowe, 1988). It is even more important in mathematics classrooms. Yackal (1989) states that small-group learning helps to establish the context for learning mathematics, a context in which students are involved in active exploration of mathematical concepts and verbalisation of their thinking.

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