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Promoting Cooperative Learning in Science and Mathematics Education: A Malaysian Perspective

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The purpose of this article is to discuss the current shortcomings in science and mathematics education in Malaysia. The use of cooperative learning as an alternative to traditional method is emphasized. Cooperative learning is grounded in the belief that learning is most effective when students are actively involved in sharing ideas and work cooperatively to complete academic tasks. This article would also focus on selected studies done locally and their expected educational outcomes. A challenge involved in implementing cooperative learning is also discussed.

Keywords: Mathematics Education, Science Education, Science, Mathematics, Cooperative Learning

INTRODUCTION

The quality of education that teachers provide to student is highly dependent upon what teachers do in the classroom. Thus, in preparing the students of today to become successful individuals of tomorrow, science and mathematics teachers need to ensure that their teaching is effective. Teachers should have the knowledge of how students learn science and mathematics and how best to teach. Changing the way we teach and what we teach in science and mathematics is a continuing professional concern. Efforts should be taken now to direct the presentation of science and mathematics lessons away from the traditional methods to a more student centered approach.

The science curriculum for secondary school has been designed as to provide students with the knowledge and skills in science, develop thinking skills and strategies to enable them to solve problems and make decisions in everyday life (Ministry of Education Malaysia, 2002). In mathematics, the curriculums provide students the mathematical knowledge and skills and develop problem solving and decision making skills for everyday use (Ministry of Education, 2003). The science and mathematics curriculum as well as other subjects in the secondary school curriculum also seek to inculcate noble values and love for the nation. Despite good intentions and directions, teacher centered teaching practices still take centre stage.

Two pedagogical limitations have been identified as the major shortcomings in traditional secondary education: lecture-based instruction and teacher-centred instruction. Lecture-based instruction emphasized the passive acquisition of knowledge. In such an environment, students become passive recipients of knowledge and resort to rote learning. The majority of work involved teacher-talk using either a lecture technique or a simple question and answer that demand basic recall of knowledge from the learners. Lecture-based instruction dominates classroom activity with the teacher delivering well over 80% of the talk in most classrooms. Generally, only correct answers are accepted by the teacher and incorrect answers are simply ignored. Students seldom ask questions or exchange thought with other students in the class. The traditional classroom is also characterized by directed demonstrations and activities to verify previously introduced concepts. Instruction is therefore not for conceptual understanding but rather for memorizing and recalling of facts. It must be noted that students who develop conceptual understanding early perform

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best on procedural knowledge later (Grouws & Cebulla, 2000). Furthermore, students with good conceptual understanding are able to perform successfully on near-transfer tasks and develop procedures and skills they have not been taught.

In the traditional teacher-centered education, the dominance of the teacher take centre stage. The students rely on their teachers to decide what, when, and how to learn. This approach to instruction works relatively well. However, it is not clear that students are learning at higher, conceptual level of thinking.

THE NEED FOR REFORM

The world is increasingly becoming "small". Actions in one part of the world exert powerful influences on other parts of the world. There is more engagement of communities and individuals from different parts of the world. The growth in science and technology is overwhelming. These forces are impossible to avert and they provide challenges and opportunities for people in the science and mathematics education. Education today must enable students to meet the challenges ahead and demands of the work environment and of daily living. Thus, students not only need knowledge but also communication skills, problem solving skills, creative and critical thinking skills in the years ahead. An American Association for the Advancement of Science (1989: 148) report advices that:

> "the collaborative nature of scientific and technological work should be strongly reinforced by frequent group activity in the classroom. Scientists and engineers work mostly in groups and less often isolated investigators. Similarly, students should gain experience sharing responsibility for learning with each other".

Now we look at the performance of Malaysian students in comparisons to students from 44 countries participating in the TIMSS assessment (Mullis et al. 2004). In 2003, Malaysian Form Two students scored 504, on average, in mathematics. Although this average score exceeded the international average but we were out-performed by students from five Asian countries (Singapore, Republic of Korea, Hong Kong, Chinese-Taipei, Japan) and four European countries (Belgium-Flemish, Netherlands, Estonia and Hungary). In science, Malaysian students scored 510, on average, which exceeded the international average of 474 (Martin et al. 2004). In comparison to other countries, we were outperformed by 19 of the 44 participating countries. The top three were Singapore, Chinese-Taipei and Republic of Korea.

The activities that are commonly encountered in science classroom, as reported by science teachers were teacher lecture (25%), teacher-guided student practice (19%) and students working on problems on their own (11%) and homework review (13%) (Martin et al. 2004). In mathematics, 64% of teachers reported that they use textbook as primary basis of their lessons. The three most predominant activities in mathematics classroom were teacher lecture, teacher-guided student practice and students working on problems on their own, accounting for 58% of class time. Other activities were reviewing homework, re-teaching and clarifying content, taking tests and quizzes and participating in classroom management tasks that are not related to the lesson content (Mullis et al. 2004).

COOPERATIVE LEARNING: AN ALTERNATIVE TO TRADITIONAL METHOD

The challenge in education today is to effectively teach students of diverse ability and differing rates of learning. Teachers are expected to teach in a way that enables pupils to learn science and mathematics concepts while acquiring process skills, positive attitudes and values and problem solving skills. A variety of teaching strategies have been advocated for use in science and mathematics classroom, ranging from teacher-centered approach to more students-centered ones. In the last decade, there is a vast amount of research done on cooperative learning in science and mathematics. Cooperative learning is grounded in the belief that learning is most effective when students are actively involved in sharing ideas and work cooperatively to complete academic tasks. Cooperative learning has been used as both an instructional method and as a learning tool at various levels of education and in various subject areas. Johnson, Johnson and Holubec (1994) proposed five essential elements of cooperative learning:

(a) Positive interdependence: The success of one learner is dependent on the success of the other learners.
(b) Promotive interaction : Individual can achieve promotive interaction by helping each other, exchanging resources, challenging each other's conclusions, providing feedback, encouraging and striving for mutual benefits.
(c) Individual accountability: Teachers should assess the amount of effort that each member is contributing. These can be done by giving an individual test to each student and randomly calling students to present their group's work.
(d) Interpersonal and small-group skills : Teachers must provide opportunities for group members to know each other, accept and support each other, communicate accurately and resolve differences constructively.
(e) Group processing: Teachers must also provide opportunities for the class to assess group

progress. Group processing enables group to focus on good working relationship, facilitates the learning of cooperative skills and ensures that members receive feedback.

Essentially, then, cooperative learning, represents a shift in educational paradigm from teacher-centered approach to a more student-centered learning in small group. It creates excellent opportunities for students to engage in problem solving with the help of their group members (Effandi, 2005).

In Malaysia, research on cooperative learning has been carried out since 1990s (Nor Azizah & Chong, 2000). The revised curriculum of the primary and secondary schools emphasized the use of cooperative learning as an alternative to traditional method of teaching. (Kementerian Pendidikan Malaysia, 2001). Cooperative learning is generally understood as learning that takes place in small groups where students share ideas and work collaboratively to complete a given task. There are several models of cooperative learning that vary considerably from each other (Slavin, 1995), for examples in STAD (Student Teams-Achievement Divisions), students are grouped according to mixed ability, sex and ethnicity. The teachers present materials in the same way they always have, and then students work within their groups to make sure all of them mastered the content. Finally, all students take individual quizzes. Students earn team points based on how well they scored on the quiz compared to past performance. Unlike STAD, in TGT (Teams-Games-Tournament) quizzes are replaced by tournaments. Students compete at tournaments table against students from other teams who are equal to them in terms of past performance. Students earn team points based on how well they do at their tournament tables. In JIGSAW, students are responsible for teaching each other the material. Assignment is divided into several expert areas, and each student is assigned with one area. Experts from different groups meet together and discuss their expert areas. Students then return to their groups and take turns teaching. Therefore care must be taken in interpreting cooperative learning research because the term can be used in many different ways.

The effectiveness of cooperative learning in mathematics and science is well established by research. Cooperative learning created many learning opportunities that do not typically occur in traditional classrooms. According to Nor Azizah (1996), cooperative learning has the potential in science classroom because of the following factors: (a) science students always work in group during science experiment in the laboratory therefore what they need is the skill to work in group (b) science laboratory is spacious with intact desk and chairs. (c) science classes are usually two periods with 40 minutes each, enough time for cooperative learning and (d) during experiment many values can be inculcated e.g cleanliness, trustworthy etc. Siti Rahayah (1998) further stated that science teachers need to try cooperative learning in order to enhance scientific skills and to increase achievement in science. Since it is impossible here to summarize the vast literature on cooperative learning, the author would only focus on selected studies done locally.

EXPECTED EDUCATIONAL OUTCOMES OFCOOPERATIVE LEARNING

Central to the goals of cooperative learning in science and mathematics education is the enhancement of achievement, problem solving skills, attitudes and inculcate values. How cooperative learning affects student achievement and problem solving skills was investigated by Effandi (2003). This study of intact groups compares students' mathematics achievement and problem solving skills. The experimental section was instructed using cooperative learning methods and the control section was instructed using the traditional lecture method. Cooperative group instruction showed significantly better results in mathematics achievement and problem solving skills. The effect size was moderate and therefore practically meaningful. He also found that students in the cooperative learning group had a favorable response towards group work. He concluded that the utilization of cooperative learning methods is a preferable alternative to traditional instructional method. Another study by Lee Guak Eam (1999), using TGT and STAD as a model found that students who were taught with a cooperative structure outperformed the students in individualistic goal structure in mathematics problem solving. Other researchers have reported similar findings that point to the achievement benefits of using cooperative learning (Faizah, 1999; Yee, 1995).

Apart from achievement and problem solving, students should also be inculcated with attitudes and values that are appropriate to their life as a student. Nor Azizah et al. (1996), in their study involving 966 pupils and using STAD and Jigsaw II structures, found that cooperative learning can inculcate values such as independent, love and cleanliness. Similar study done by Siti Rahaya (1998) using STAD/Jigsaw as a model which involved 1180 students from 18 schools, concluded that the values of self dependent, rational, love and hard working are prominently inculcated. It was also found that cooperative learning can enhance scientific skills, promote enquiry learning and increase science achievement. The students were found to enjoy learning in groups. According to Nor Azizah and Chong (2000), the result of the two studies varies due to differences in school background and type of students in the respective school.

Attitude has also been the focus of more than one study in cooperative learning. A study conducted by Abdul Halim (2000) found that students in the experimental group held positive attitudes toward science. Zainun (2001) examined the effect of cooperative learning using STAD as a model. Results indicated a positive attitude toward mathematics. Most students also have positive perception towards STAD. Another study conducted by Mazlan (2002) found that students in the experimental group held positive attitudes toward mathematics. However, a study by Meriam Ismail (2000), using TGT (*Teams Game Tournament*) showed that there was no significant difference in attitudes toward mathematics between experimental and control groups. The short treatment period of 3 ½ weeks might be the possible reason for no significant difference between the two groups.

CHALLENGES

Incorporating cooperative learning in science and mathematics classroom is not without challenges. Initially, teachers and students have to face various challenges. The main problems which arise include the followings:

- *Need to prepare extra materials for class use*

The need to prepare materials require a lot of work by the teachers, therefore, it is a burden for them to prepare new materials.

- *Fear of the loss of content coverage*

Cooperative learning methods often take longer than lectures. Teacher conclude that it is a waste of time

- *Do not trust students in acquiring knowledge by themselves*

Teachers think they must tell their students what and how to learn. Only the teachers have the knowledge and expertise.

- *Lacks of familiarity with cooperative learning methods*

Cooperative learning is new to some teachers so they need times to get familiar with the new method. Intensive in-service course can be implemented to overcome the problem.

- *Students lack the skills to work in grou*p

Teachers are often concerned with students' participation in group activities. They think that students lack the necessary skills to work in group. However, according to Ong and Yeam (2000) teachers should teach the missing skills and/or review and reinforce the skills that students need.

CONCLUSION

Changes are needed in science and mathematics teaching. Teachers should give less emphasis on students acquisition of information, presenting scientific and mathematical knowledge through lecture, asking for recitation of acquired knowledge and working alone. More emphasis should be given on students understanding of a particular concept, guiding students in active learning, providing opportunities for discussion and elaboration and encouraging them to work with peers and teachers. In a recent development, the government has introduced the use of English as the medium of instruction in science and mathematics. This move would provide students the opportunities to keep abreast with the rapid development of knowledge in science, mathematics and technology. Collaborative effort with students from other countries is now possible and should be supported.

Findings of cooperative learning study should be disseminated to all schools in Malaysia to encourage other teacher to consider this instructional approach. A staff development program should focus on the needs of the teachers. Needs analysis study should be done before running any courses. The courses should be hands-on and include basic concepts of cooperative learning and the rationale for using cooperative learning in schools setting. Although cooperative learning cannot cure all the problems faced by teachers in teaching and learning science and mathematics, it may serve as an alternative to traditional method of teaching.

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