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Constructive Approach: Cooperative Learning in Mathematics

*1Mariadoss Anandaraj & 2Munusamy Balamurugan

*1Ph.D Research Scholar, School of Education, Pondicherry University, Puducherry (India)
2Professor, School of Education, Pondicherry University, Puducherry (India) (India)

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***Corresponding Author**
Email: anandaraj.pu[at]gmail.com

ABSTRACT

The cooperative learning plays a significant role in the students' learning in the classroom. A teacher of more advanced peer increases the level of support according to the students' need for the desired learning outcome. It is based on the social context of developmental learning which takes place in the small or large group or social interactions and discussions until the successful completion of the task. The present study aims to discuss the definitions of cooperative learning and its meaning and types of cooperative learning, principles, and cooperation in the classroom. Also, discuss the John Dewey's social environment for education, Bandura's cognitive theory and Vygotsky's theory for social learning in which zone of proximal development of students and types of cooperative learning approach, keys to successful group work such as classroom culture, nature of classroom and structure of the classroom. Moreover, discuss the teachers' responsibilities in establishing cooperative learning and professional development.

1. Introduction

Policy documents (NCTM, 2000; Ministry of Education, 1992) emphasize the importance of incorporation of problem-solving and small group contexts in learning in the classroom of students' age group between 5 and 18. Cooperative Learning promotes students to solve problems in mathematics (Sahlberg & Berry, 2002). Teachers identified that there are more benefits using cooperative Learning in the classroom by which students improve their self-esteem, create safe learning environment, showcase learning outcome constantly (Jenkins, Antil, Wayne, & Vadasy, 2003).

Wells (1999) emphasize that carefully structured classroom by the teacher for students' interaction with others is an important engine for learning. Effectiveness in cooperative learning among students is highly measured and documented and wide range of research evidence demonstrates the benefits from, cognitive learning and social and emotional perspectives (Plante 2012; Kyndt et al. 2013; Gillies 2008, 2014). More significantly there has been extensive research on the effectiveness of the cooperative-learning method of peer group learning (Topping, Duran, and Van Keer 2015; Bowman-Perrott et al. 2013). According to Johnson and Johnson (2014), cooperative learning helps the learners to improve their content enrichment, skills and strategies to face the challenges of the twenty-first century.

1.1 Cooperative Learning

The natural way of learning that happens when students join as small groups to do the tasks by helping, sharing the ideas with each other. Students improve their interpersonal and intrapersonal mathematical communication skills. In the group learning, all members of the group get the opportunities to interact with each other regarding the learning tasks. When students work cooperatively, they learn to help and receive help from others, listen to others views and ideas and gather all information and arrive at the common conclusion of the tasks at the end. However, in small-group learning setup, the teacher telling the students to work together does not make any assurance that they will work cooperatively.

All groups in the classroom should be well-organized by the teacher to make sure that everyone in the groups will work together if students are to get the benefits widely attributed to cooperative learning. Once the students understand the roles and responsibilities in the group and feel the importance of interdependence and their coordination with group efforts to achieve the common goals, and then they will begin to use the interpersonal and small-group skills that will facilitate their efforts (Gillies, 2003c).

2. Cooperation in the Classroom

Cooperative learning is a positive relationship among the peer group members which will be characterized by their support and usefulness to others. In the discussion, many concepts relating to tasks will be considered in the classroom which includes competition and motivation, cooperative and competitive activity, self-selected and assigned grouping, roles and responsibilities, peer teaching and peer tutoring, risk-taking to help others and trust others and mastery over the learning and performance outcomes.

Aspects of cooperation and cooperative learning activity can be classified as cognitive or physical. In the cognitive cooperative activities wherein one member helps the other member of the group to learn, helping activities includes doing (skill-based), showing (skill-based), telling (knowledge-based) and explaining (level of understanding). And the physical sharing activities include borrowing leaning materials, giving, hiring and taking turns. Members in the groups retain autonomy in cooperative learning activities and their learning goals are not judged by the other learner in the group.

3. Theoretical Background

3.1 Vygotsky's Social Learning

Students' level of potential development can be measured through their problem-solving ability under the adult supervision. There can also be students' cooperative learning with knowledgeable peers. Vygotsky emphasized the concept formation in the cognitive development of a child. In the process of concept formation as children need to undergo by referring to the sources available for every step of learning to carry out the task, including the use of tools, gathering the suitable data by which children would arrive at how to organize the learning and how to direct themselves towards positive behavioral attitudes. Every student's cultural development takes place twice; one is the psychological level and the other is the sociological level. The knowledgeable student in the group can support his or her partner as well as other members. Students working as pairs in groups feel more comfortable and feel happy to do any task. The pair in the group can have discussions about tasks interestingly. Every successful social interaction helps the students' zone of proximal development (ZPD). The teacher can assess the students' progress on ZPD for a specific problem-solving situation.

3.2 Bandura's Cognitive Theory for Social Learning

Bandura's cognitive theory for social learning directs learning towards active process in which students should construct their knowledge in the social nature of learning. His theoretical views are fully consistent with social constructive thought. He highlights that human lives are not lived in isolation and the life of an individual should prosper by making the positive relationship with others to enhance learning. Every individual should develop their learning skills and empower the knowledge by polishing their brain gradually with social learning atmosphere. Moreover, all unlearning will be uprooted, and then there will be fruitful learning. Bandura writes the term "collective agency" which means more individuals join together to accomplish the common goal. The broad aim of collective agency is people working together and share their ideas and beliefs to reach the common goals to improve in order to sustain their memory.

3.3 John Dewey's Social Environment for Education

Minds of young students develop by taking part in group activities in a social interest; the meaning of intelligence of students is meaningful recognition of their experience. The social environment will be educative if the student participates in some group activities. Dewey emphasizes that psychological and sociological aspect of education in which both are equally important. If anyone of them is ignored, then there will not be any good results from the students' community and of course the poor result not by the mistake of students. The schools should certainly apply both the educational techniques by prior training for teachers by the educational psychologists so that teachers' learning for the students' learning will be improved. Dewey's method of education is learning by doing, the teacher should guide the students and the work of the school should organize the learning activities according to the interest of the students.

3.3.1 Social Environment Help in Educating the Students

Students share their experience with the group members. They participate in many common activities. When the student involves in teamwork gets the different ideas. According to Dewey the education of a child in the social environment should be the stimulus to action and be making the student a co-partner in the group activity. The students' direct experience learning by doing then there will be behavioral changes and develop their minds. The three dispositions such as the mathematical language development, the change of attitudes and characters and develop self-interest and gets appreciations.

4. Types of Cooperative Learning

4.1 Formal Cooperative Learning

According to Johnson and Johnson (1994a), formal cooperative learning consists of group members working together, for one of several learning sessions, to achieve shared common goals and jointly complete specific tasks and assignments. In the formal cooperative learning groups, instructors can play the following roles:

- Make a number of pre-instructional decisions and specify the objectives for the lesson; they decide both academic and social skills, the size of groups, the method of assigning participants to different groups, the roles of participants will be assigned, the materials needed, and the arrangement of the room.
- Define the statements clearly lead to the assignment, teach the required concepts and strategies with simple examples, specify the positive interdependence and individual accountability, give the criteria for success, and explain the expected social skills to be used.
- Observe participants' learning and intervene within the groups to provide task assistance or to increase participants' interpersonal and group skills.
- Assess participants' learning in each group and help them in the process of learning in which how well their groups functioned.

4.2. Informal Cooperative Learning

Informal cooperative learning setting group members work together to achieve a joint learning goal in a short time, ad hoc groups that last from a few minutes to one class period (Johnson, Johnson, and Holubec 2009). During informal cooperative learning while delivering a lesson, the demonstration to (a) focus participants' concentration on the tasks to be achieved; (b) create a learning atmosphere in the classroom; (c) help the participants to set expectations, according to learning tasks covered in a training session; (d) make sure that the participant cognitive process of learning and rehearse the practice again; (e) summaries the learning and then move to the next session and (f) concludes the instructional session. Informal groups are often organized so that participants engage in the maximum of five minutes of focused discussions before and after the teaching and discussions with partners entertained throughout the teaching.

5. Principles of Cooperative Learning

5.1 Heterogeneous Grouping

In the classroom students as groups accomplish the tasks by learning cooperatively are mixed without discrimination of variables such as gender, ethnicity, community background, religion, personality, age, financial background, language ability, diligence, and complexity.

5.2 Cooperative Skills

Cooperative skills such as logical reasoning, discussion, arguing and so on needed to work with others. Due to many reasons, students may lack these skills, they may hesitate to interact with others because of the barrier in communication or feel the risk to apply the skills. There are more learning sources available from websites on cooperative learning to develop collaborative skills.

5.3 Group Autonomy

This principle group autonomy encourages students in the groups to search the learning resources for themselves rather than always depending on the teacher. Teachers used to get the frustration that how to tackle the problems of students in the groups and how to interact either in a particular group or with the entire class. They may be tempted sometimes, but need to balance the situations and think how to guide them and trust the peer group interaction to perform many activities they have felt responsible for themselves (Johnson et al., 2000).

5.4 Maximum Peer Interaction

When group activities are not used in the normal classroom, the teacher interacts with students and there will be more teacher talks by the teacher on the other hand, when group activities are used the teacher divides the class students into small groups. For example, 40 students can be divided into four groups so that 10 students in each group can speak simultaneously. Thus, students get more benefits out of their peer group interaction experience (Kagan, 1994).

5.5 Equal Opportunity to Participate

One or two members in each group in the classroom try to dominate the group and may think that know more than others, whereas cooperative learning shows many ways of promoting more equal participation among group members (Kagan, 1994).

5.6 Individual Accountability

Every student in the group perceives that he or she has to accomplish his roles and responsibilities leading towards common goals.

5.7 Positive Interdependence

All students in the groups share their roles and responsibilities to accomplish the common goals and all aiming to succeed as a group, depend on each other positively and strive towards excellence.

5.8 Cooperation as a Value

When students work in the group develop the social nature of helping each other share their ideas with others, share the learning materials, and develop the mathematical communication. Everyone in the group feels proud and think that they are one team and common goals so that collectively put their effort to showcase their talents. Every student aiming to do the tasks, develop the friendly relationship and trust each other and their hands to help the student who is in great need. Moreover, they understand each other's emotions and motivation to learn. Certainly, the spirit of cooperation will help them in community development in the future.

6. Think-Pair-Share

Think-Pair-Share technique is to motive the students in the group to share their ideas on a specific topic, problem or issue. Teacher can use this technique in the classroom for the within the well planned lessons and also easy to implement it spontaneously, conceptual clarity, search and filter the information, generalize and draws conclusions motive the peer group learning.

7. Cooperative Learning Approaches

7.1 Student-Teams-Achievement Divisions (STAD)

According to Slavin, (1995) Student-Teams-Achievement Divisions involves in recognition of team and group responsibilities for learning in different ability groups. This type of learning design helps the students in different learning situations. For example, defining aims and objectives, solution to the problems and including computational skills in mathematics, mathematical language, and scientific facts.

7.2 The Jigsaw Classroom

7.2.1 Jigsaw 1

Jigsaw 1 is a type of cooperative learning design in which maximum of 6 members can work together on the given materials in the classroom and the whole structure of the work will be divided into small parts to connect each step for coherence in learning. However, in the process of construction, every student is responsible for each stage of the learning. In Jigsaw classroom, members in different groups having different cultural backgrounds cooperate each group by showcase their learning output of different parts to reach a common goal (Aronson et. al., 1978).

7.2.2 Jigsaw 2

In Jigsaw 2 classroom students in each group consists of four or five. In Jigsaw 2 classroom students in each group consists of four or five. The teacher assigns the topics to different groups focusing to become expert in learnt lessons. Students with the same topics discuss the learning materials and analyze the details to present in the group. Then every student actively involves in the quiz completion in their group and counts the team scores.

7.3 Learning Together

This approach has the following components developed by David and Roger Johnson (1994).

7.3.1 Face-To-Face Interaction

Though there is a common discussion in the classroom among group members, some portion of work must be done by every individual. Members in the group can interact with others for clarification, share their thoughts and ideas and provide each other their feedback, involve in the process of helping, teaching, supporting, encouraging each other to reach the

common goals. Higher order thinking such as analysis, synthesis, and evaluation develop; individual in the group able to reason out why the mistakes happen during problem-solving; How can generalize the whole idea?; How can draw the conclusions?.

7.3.2 Positive Interdependence

In the classroom every student in the groups has the role of contribution to make the collective effort; can depend on and trust each other towards working the common goal. Each member's effort it the groups is very much required and indispensable for the group success.

7.3.3 Individual Accountability

Every member in the group must be accountable for their knowledge sharing, and attaining mastery level of learning of the all the materials to be learnt to the group's success.

7.3.4 Development of Interpersonal Skills

Apart from the above four components learning together in cooperative learning approach Socio-emotional development, peer group interaction and success of every student are important. Students in heterogeneous groups consist of two to six members in every group work together, discuss the tasks with the team building spirit.

7.4 Group Investigation

This approach combines both students who learn independently and students who work together in the group of 2 to 6 members in each group and a group will be recognized to reward for individual 's performance. For the classroom teaching of mathematics, the teacher plans and selects a problem for the different groups to study and gives freedom to students to decide and explore the problem in their own way of thinking. For every student in the group work will be assigned to engage actively. Then they join as a team, gather collective ideas, integrate the learning, and finally summarize them as a result. The role of the teacher is to investigate and develop the spirit of cooperation in every group and encourage their sincere effort. Hence, there would be more opportunities for students to solve day-to-day life problems.

7.5 Cooperative Scripting

Students work in pairs in the group so that then they are more comfortable to share the ideas and can discuss further. And in pair work summarizes the information and orally presents their work to each other enthusiastically. When one student of the pair work explain the learning outcome, then the other listens, observes the style of explanation and corrects the errors if any, and gives a performance report. Then the other student in pair presents, the student who presented now play the role of teacher and evaluates it.

8. Keys to Successful Group Work

The three key elements such as classroom culture that supports cooperation, collaboration and group work, the structure for groups and tasks and strategies that nurture the work.

8.1 Classroom Culture

According to Middleton and Jansen (2011), students in the classroom need to trust each other to learn together in the small-group settings. Teachers must create a good environment in the classroom for students to develop a social relationship with others, preparing a lesson plan for the academic year, term-wise lesson plan, unit-wise lesson plan as per the constructive, cooperative learning for the teaching of mathematics so that students can gradually break down the social barrier and cultivate the habit of trusting each other. Students in the group can understand each other better and focus on self-interest will be transformed into group achievement. Then everyone will be committed to his or her contribution and be thinking about success for all.

According to Sharan and Sharan (1992), more studies on cooperative learning reveals that students are working in groups and their experience is making the decisions on their own rather than what to express with a good sense of control over and responsibility for their own learning. Cohen (1994) stresses the importance of the teacher as a learner focus towards empowering the skills for teaching secondary school mathematics classroom.

8.2 Nature of Classroom

Teachers should continue to invest in community building in the classroom throughout the year. They should organize well the pre-planned designs for group activities otherwise there will not be further improvement between the groups in the subsequent months. The effort to nurture the classroom might be excellent in the beginning. There would not be the effective result at the end. Therefore, the teacher must constantly facilitate the students in different groups using constructive, cooperative learning lesson plan and alter the lesson plan if it does not affect. This alteration should be done after completion of every unit. The teacher has to maintain a personal diary and write the feedback on the lesson taught for self-evaluation. When students have the doubts, they would immediately try to get the answer from the teacher, but the answers might be available from the peers. If the members of the group do not know the answer for the problem, then they can get the guidance from the teacher to solve it.

Teachers should invest in different classroom activities that purposely attend to succeed students learning and provide them opportunities to analyze and evaluate the group work as a project at the end. If the teacher facilitates students learning systematically in small groups, as well as the full class, will learn positively more from team-building activities they can create a wonderful atmosphere in the classroom which is community development. Regular students' feedback on different activities will help the teacher to polish his lesson plan writing, which will direct the students better for existing students. Teachers must be sure about their instructional motivation and arousal to nurture the learning so that students would be eagerly waiting for the next class (Willis, 2010).

8.3 Structure of Classroom

Teacher has to ensure that the students' active participation in the process of learning in their respective groups and define the roles and responsibilities for every group so that everyone in the group can learn new things from others.

Moreover, students can balance their learning each other in the group. The roles assigned by the teacher can help them to check the pre-requisite knowledge or previous mathematics experience. Those who are lacking fundamental knowledge of mathematics would be trying to search for basic needs with the peer group to connect previous learning to new learning situations. For example, algebraic operations, algebraic formulae, statement of the problem and so on. Students who are good at mathematical languages in the group can help the less ability students (Shulman, Lotan, & Whitcomb 1998). The reason for the less ability of some students in the class could be parents are illiterate, unable to study at his or her home due to quarrel between father and mother, lack of facilities at home and etc. therefore before divide the classroom in to small groups, the teacher has to put mixture of students in every group. Then they can bridge the gap unlearning.

The six features of group work tasks and its worthiness such as aiming towards big idea develop multiple abilities, open-endedness during the discussion; develop positive interdependence, student's accountability, and evaluation. Importantly in mathematics classroom discussion, recognize others' contribution, collective work to enhance computational skills and acquire the skills solving problems in different methods (Watanabe, 2012). When a student trying to solve the problem, might try hard to get the solution, then there would be the disappointment at the end, if the student does not get the solution after several attempts. Hence, the key to success is worthy of group work.

9. Teachers' Responsibilities in Establishing Cooperative Learning

Teachers should create the inclusive learning environment in the classroom for all students. They should establish child-centered learning in which students involve in interaction, meaningful learning, and constructive way of learning, problem-solving method and reflective process. Teachers should actively teach children that how to interact socially in groups and should be associated with peer-group. They can facilitate students' dialogue with peers by helping them to use different types of shortcut methods to get the solution in mathematics. Students cannot feel burdened while learning the theorems or formulae when learning is in the form of discussion.

Teachers should assign tasks to every group where students need to think and discuss and contribute each other to accomplish the common goals. They should plan well before the instruction to develop students' thinking and guide them in the process of learning so that students can learn to think better and sole the problems. They can facilitate students that how to develop mathematical thinking, for example, asking probing questions systematically from lower order questions to higher order questions, reasoning skills, sequencing. Also, facilitate students in the group to develop mathematical communication through coding and decoding process.

10. Cooperative Learning for Professional Development

Teachers must know the important themes before implementing cooperative learning in the classroom for effective learning. First, the comprehensive idea about cooperative learning and need of the learners (Sharan, 2010; Johnson and Johnson 1989; Brody and Davidson 1998) and to provide more opportunities for teachers to implement theoretical ideas of cooperative learning in to classroom practices (Brody, 1998). The need for the cooperative learning must be discussed and learned then it should be practiced in the teacher-training period before they implement in the classroom. Certainly the first-hand experience the use of cooperative learning will help the teachers teach effectively and facilitate to nurture the learning (Veenman et al. 2002; Delli Carpini 2009; Lyman and Davidson 2004), the use of cooperative learning along with modeling in the teacher-training period will support the novice teacher in real teaching (McAlister 2012; Loughran and Berry 2005). When the above factors incorporated in teaching practice with many phases of cooperative learning to support the peer-group students then there can be more effective learning (Harris and Hanley 2004).

11. Conclusions

Teachers of mathematics should update the knowledge and skills that are very much required to handle the students in different groups in the classroom by learning together with co-teachers of mathematics and implementing the educational theories such as John Dewey's social learning and Bandura's cognitive learning and Vygotsky's social learning in the classroom will ultimately enhance teachers' ability to improve professionally.

In order to balance the inequalities in the classroom the teacher should have effective planning and preparation using the cooperative learning techniques in the aspect of psychological and sociological ways to challenge the process of group work. Moreover, the teacher should stretch the students' brain to the possible extent through to develop interpersonal communication and intrapersonal communication relating to axioms, postulates, strategies and formulas and so on to learning mathematics. The future study should focus on helicopter views in the cooperative learning settings in the classroom to enrich teaching and learning of mathematics.

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