Effects of Metacognitive Scaffolding on the Mathematics Performance of Grade 6 Pupils in a Cooperative Learning Environment

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Abstract:

This study investigated the effects of metacognitive scaffolding on the mathematics performance of grade VI pupils in a cooperative learning environment. It involved the grade VI pupils of St. John's School. It made used the pretest-posttest quasi-experimental research design. The instruments utilized were mathematics achievement test and interview protocol. Percentages, means, t-test for paired samples and analysis for covariance (ANCOVA) were used. Findings revealed that: the number of male pupils was almost equal to the number of females; their mathematical ability ranged from poor to excellent; the mathematical ability in the Cooperative Learning (CL) only and Cooperative Learning with Metacognitive Scaffolding (CL with MS) group varied considerably; performance of the pupils significantly increased; mean scores in each group showed significant difference; and the comparison of the mathematics performance of pupils when grouped according to mathematical ability showed significant difference but not for gender. Pupils exposed to CL with MS performed better than those exposed to CL only. The use of metacognitive scaffolding helped the students to fully benefit from cooperative learning. The difficulties of pupils in Mathematics were as follows: understanding the concept, analyzing the problem, memory problems, math anxiety/attitude problem and lack of basic math skills.

Key Words: *metacognitive skills, cooperative learning, mathematics performance*

Introduction

Nowadays, the children are growing up in a world permeated by mathematics. Mathematics has been widely used as seen through the technologies used in homes, schools, and the workplaces. Many educational opportunities and good jobs require high levels of mathematical expertise. Mathematics is a universal, utilitarian subject, that is, so much a part of modern life that anyone who wishes to be a fully participating member of society must know basic mathematics. For students to participate fully in society, they must learn mathematics with understanding, how to connect mathematical ideas, and how to reason mathematically. Students who cannot reason mathematically are cut off from whole realms of human endeavor. Students without mathematical understanding are deprived not only from opportunity but also from competence in everyday tasks (Kilpatrick et al., 2001). So mathematics instruction should emphasize such variables that result learning with understanding in order to meet the changing demands of the society.

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The mathematics classrooms are dominated by seatwork, homework and review. These instructions lead to teaching strategies that require mathematics teachers to concentrate on mastering procedures needed to solve routine tasks and problems. In addition, these instructions necessitate mathematics teachers to fragment mathematics materials and to include many topics, with a considerable amount of repetition of content which is divorced from reality. The traditional sequence of teaching placing value, digit numbers, fractions, ratio, decimals, percentages, and geometry tends to fractionalize mathematical knowledge instead of integrating and connecting it. This instruction influences students' views of mathematics and may make them unable to transfer what they have learned to new situations in the real life. Moreover, this instruction does not encourage students to invest their reasoning, connection, and metacognitive strategies in their learning. That is, students often receive problem-solving procedures from the teacher without actual participation in planning, monitoring, and evaluating their learning. In this environment there is no opportunity for students to connect mathematical relationships between what they have learned and the current situations in which these connections enable them to recognize the importance of mathematics in all parts of life (Baroody, 1998), and learn mathematics with understanding (Carpenter and Lehere, 1999; Kilpatrick et al., 2001).

Student's difficulties in doing mathematics are partly attributed to misconceptions or shallow conceptions of domain knowledge (Feltovich et al., 1996), they are, to a greater extent, due to a lack of metacognitive. So students need to be taught mathematics through an effective instruction that enables them to acquire and apply metacognitive strategies, reason mathematically, and thus learn mathematics with understanding.

In other words, students have to be taught and supported to plan, formulate and represent the mathematical problems, analyze and identify the mathematical variables, connect the relationships among the mathematical variables, ask themselves questions regarding mathematical situations, reason mathematically, evaluate their strategies and outcomes (Kilpatrick et al., 2001; King, 1992), and to work cooperatively to learn with understanding. Particularly, students need to learn how to learn, that is, to be metacognitively trained. To date, insufficient attention has been given to the important role the metacognitive strategies play in improving mathematics performance and mathematical reasoning.

For this reason, the researchers felt the need to investigate the effect of metacognitive scaffolding, cooperative learning on student's mathematics performance as well as their difficulties in Math. The purpose of this study was to find out the extent to which the cooperative learning with metacognitive scaffolding and cooperative learning methods could play an important role in improving student's mathematics performance. The researchers also strived to find out prevailing situations in St. John's School concerning this study.

The study investigated the effectiveness of using metacognitive scaffolding in a cooperative learning environment on pupils' mathematics performance. Specifically, the study aimed to: describe the profile of pupils in terms of: gender and mathematical ability; assess the mathematics performance of pupils before and after instruction when exposed to: CL with MS; and CL only; compare if there is a significant difference in the mathematics performance of pupils before and after instruction when exposed to CL with MS and CL only; find out if there is a significant difference on the mathematics performance of pupils exposed to CL with MS and CL only when grouped according to gender and mathematical ability; ascertain the significant difference between the mathematics performance of pupils when exposed to CL with MS and CL only; and identify the difficulties and misconceptions of pupils in grade 6 Mathematics.

Review of Literature

There are four basic principles that define cooperative learning, namely, positive interdependence, individual accountability, equal participation, and simultaneous interaction (Kagan, 1994). Kagan uses the acronym PIES to represent these principles, and asserts that unless all of these principles are implemented, cooperative learning is not taking place. These four principles are discussed below.

Positive Interdependence means that a gain for one student is associated with gains for the other students. Students should be guided to understand that, "the success of every team member depends upon the success of each other member", and "if one fails, they all do." (Kagan, 1994:Ch. 4:7). This "sink-or-swim-together" mentality is the central theme of cooperative learning. One way to foster positive interdependence is to not give each group member all of the necessary materials to complete the assigned task, thereby forcing the students to share and work together.

Individual Accountability means that each group member is responsible for his or her own learning, and for contributing to the learning of his or her group members. If the teacher is to assign a group grade, it is also important to assign individual grades to each student, based on exams and other work which is done independently.

Equal participation is self-explanatory, and refers to the fact that no student should be allowed to dominate a group, either socially or academically, and that no student should be allowed to loaf, or "hitchhike" on the work of other group members. Kagan cautions that equal participation does not occur automatically, and that steps must be taken to ensure that it occurs. In particular, Kagan posits two techniques to ensure equal participation. The first is turn allocation, which means that students are expected to take turns speaking, and to contribute to the discussion when their turn comes. The second is division of labor, which means that each group member is assigned a specific role to play in the group. Group roles are discussed in details below.

Simultaneous interaction in cooperative learning results from arranging the students in small groups, seating the students face-to-face, and creating a group task such that all group members need to work together to obtain a solution. This could be contrasted to a traditional classroom setting in which all of the students are facing forward, working independently, and spending the overwhelming majority of the time sitting quietly, listening only to the teacher.

Many individuals consider mathematics as mostly computation. So it is imperative that most of them are conversant with only the computational aspects of mathematics. They also tend to contend that it is important in the school curriculum and for traditional methods of instructing students in computation. For them, the broad goal of learning process is to master the computational procedures regardless to what actually mathematics is about and regardless to the learning process itself. That is, they have misconceptions about what mathematics is about and they do not take how students learn, their experiences, their metacognitive strategies, and their attitudes toward mathematics into account (Brown, 1987; National Council of Teachers of Mathematics, 1989; Thompson, 1992).

In most traditional mathematics classrooms, students are frequently expected to learn facts, concepts, and skills divorced from any real context. They are drilled in arithmetic without applying the skills to problems that mean anything to them. They usually learn abstract formulas in mathematics out of realistic contexts. So their learning are likely ineffective, and although they can acquire mathematical operations they are usually unable to apply them in different situations as Clark (1995) has concluded that when students interpret an activity as unrealistic and non-meaningful, encoding, representation, and learning are likely to become over simplified and narrowly school-focused. Ertmer and Newby (1996) assert that "If schools are going to help all students become expert students, the metacognitive strategies of students must be acknowledged, cultivated, and exploited. A major function of all schooling must be to help create students who know how to learn" (p.22). Therefore, effective mathematics instruction should assist students to activate the metacognitive strategies in order to be able to learn mathematics with understanding and reason mathematically.

Studies reported that female's brain is more developed than the male. Female learns easily in school, they achieve better results than males in school because females are more focused and stable. Moreover, females reach brain and psychological maturity faster before males because research proved that there is a small nerve in the left side of the brain that grows faster in females. This nerve is the reason why females are more intelligent in the early stages. Males mature slowly than the girls which is the reason why they bloom late. Nevertheless, studies proved that more males excel in math than females.

From the study of Euldan (2011), Researcher Oxford, as cited by Bacabis (2000) reported that females apply a great number of ways and strategies compared to males. On the other hand, in the study of Carmelo (2008), she stated that the picture for boys in math is less complicated. Boys of all ages and races are scoring as high – or higher – in math than ever before.

Students in 7-11 years stage (concrete operations) have some abilities, and some higher levels of thinking that enable them to work in the next stage (formal operations), but they need a certain guidance and support from more capable and competent adults to reach that stage. These children need to narrow their zone of proximal development; they can be pushed to the next stage or can narrow their ZPD by scaffolding and supporting them. Vygotsky (1978) believes that students cannot independently narrow the zone of proximal development (Rosenshine and Meister, 1993). So the concept of scaffolding becomes a critical technique to bridge the gap between what the students can accomplish independently and what they can achieve with assistance or guidance of others. Therefore, scaffolding is a technique of teaching where the learning is assisted by the teacher or / and other capable peers (Slavin, 1994; Rosenshine and Meister, 1993). When using scaffolding, students are provided with "a great deal of support during the early stage of learning and then diminishing support and having the students take on increasing responsibility as soon as they are able" (Slavin, 1994, p. 49). In this way, students are able to narrow the zone of proximal development initially with support, and retain this level of achievement as support is reduced. So awareness of a student's ZPD helps a teacher gauge the tasks student is ready for, the kind of performance to expect, and the kinds of tasks that will help the student reaching his or her potential. Fading of support during scaffolding should eventually result in self-regulated learning, and thus more self-reliant students. Recent developments in pedagogy and educational science also picture this more active, self-reliant role of students, self-regulating their own learning process and actively creating new knowledge. For self-directed learning, metacognition, "one's awareness of one's own cognition" (Alessi and Trollip, 2001, p. 28), is needed which is so helpful for lifelong learning. As students are being supported to work self-reliantly, they can learn how to learn, which is critical for their professional futures where they will be required to keep themselves up-to-date in their own professions. Brown et al. (1991) describe scaffolding in reciprocal teaching which enhances interactive learning. Interactive learning provides students with situations that push the boundaries of their abilities and actively engage them in tasks. It also gives students an opportunity to be students as they come to master a task and, once they have achieved mastery, to be teachers of those who are still learning. Brown et al. (1991) add that research indicates that problems which are too difficult at first for students to handle on their own later become problem types they can solve independently when they have first received support and worked on them in a small group setting. That is, the teacher scaffolds students and students scaffold themselves. Therefore, scaffolding enables students to learn a body of coherent, usable, and meaningful knowledge within their zone of proximal development and "to develop a repertoire of strategies that will enable them to learn new content on their own" (p.150).

Therefore, in the present study, the teacher in the cooperative learning with metacognitive scaffolding group scaffolded students by asking metacognitive questions and students were coached to ask themselves and their group members metacognitive questions based on materials presented in the classroom. When students in cooperative learning settings ask and answer the metacognitive questions, they are more likely to understand the materials better, develop new perspectives, reason and explain solutions, and recognize and fill in gaps in their understanding.

Methodology

The researchers used pretest-posttest quasi-experimental design. Descriptive method was also used in collecting data to test hypothesis or to answer questions concerning the current status of the participants under study. This follows logically a process from data collection, quantification, statistical treatment, analysis and interpretation. This study gathered both quantitative and qualitative data. The qualitative part of this study was the determination of pupils' difficulty and possible misconceptions on the topics included during the conduct of the investigation. The study was conducted at St. John's School, Bonifacio Drive, Malaybalay City, Bukidnon. St. John's School of Malaybalay City is a non-sectarian private school that was founded on 2002 by a group of professional educators.

The respondents of this study were the 43 grade six pupils. The researchers conducted the study to the two grade 6 heterogeneous sections of St. John's School. The choice of the groupings for CL with MS (21 pupils) and CL only (22 pupils) was done randomly. There were 43 of them and they were of different level of mathematical ability (excellent, very good, good, satisfactory, fair, and poor). It is in the grade school level where the basic concepts of Mathematics are being learned by the students.

In this study, two major instruments were used to assess students' mathematics performance in terms of metacognitive scaffolding and cooperative learning. A mathematics achievement test (pre-test and posttest) were also used to assess students' mathematics performance before and after instruction when exposed to cooperative learning with metacognitive scaffolding and cooperative learning only. The topics covered were for the Third Quarter which was about Geometry. It consists of 50-items multiple choice tests which were answered within an hour. The researcher made a scale for the scoring as illustrated below. It is the scale used by St. John's School in getting the percentage of the score. Percentage is computed by dividing the raw score and the total score multiplied by sixty then add 40 (Raw score ÷ Total Score x 60 + 40).

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Table 1: Scale to interpret the performance of pupils in the Mathematics Test.

RANGE	LEVEL
A (95-100)	Excellent
A- (90-94)	Very Good
B (85-89)	Good
B- (80-84)	Satisfactory
C (75-79)	Fair
D (75 below)	Poor

A survey or interview was used to identify pupils difficulty and possible misconceptions on the different topics discussed. The researcher asked questions about the student's difficulties in mathematics. Information gained from the interview was used for descriptive purposes to support or to refute findings from the other data sources especially in metacognitive dimensions.

The data collection was personally carried out after all the necessary permissions were obtained. Prior to any instruction, the pre-test was administered so as to determine the students' mathematics performance before using metacognitive scaffolding and cooperative learning. The same process was done for the post test or after the pupils was exposed to metacognitive scaffolding and cooperative learning. Interviews were also done to the pupils before and after taking the test so as to determine their difficulties. Interviews were written and recorded using the cellular phone.

The mathematics performances of students were described in terms of the mean and standard deviation. Descriptive statistics using means and percentage were used to determine the performance of pupils. It was also used to tabulate and count frequency counts, percentages, averages, or spreads.

The t-test for paired samples was used to compare the significant difference on the mathematics performance of pupils based on the pre-test and post test results. On the other hand, the t-test for independent samples and ANCOVA were also used to compare the significant difference on the mathematics performance of students when grouped according to their profile.

Descriptive qualitative presentation was used in the showing the data collected from the interview of all respondents in the study regarding the difficulties that they encountered in learning Mathematics.

Findings

Respondents of the study comprised the forty-three (43) pupils of St. John's School with 21 and 22 pupils in each section. As shown in Table 2, the profile is grouped into two as CL only and CL with MS. In terms of gender, for male 10 (45.5%) are in CL group while 11 (52.4%) are in CL with MS group, for female 12 (54.5%) are in CL group while 10 (47.6%) are in CL with MS. Out of the total number of grade VI pupils, 21 (48.8%) are male while 22 (51.2) are female. Thus, the number of male and female is just almost half in number. In terms of mathematical ability, for CL group 5 (22.7%) fair, 4 (18.2%) are very good and good while 3 (13.6%) are excellent, satisfactory and poor. For CL with MS group, 5 (23.8%) are good, 4 (19.0%) are very good, satisfactory and poor while 2 (9.5%) are excellent and fair. Out of the total number of grade VI pupils, 5 (11.6%) are excellent, 8 (18.6%) are very good, 9 (20.9%) are good, 7 (16.3%) satisfactory, fair and poor.

Table 2. Profile of the Pupils

INDICATORS	CL only n = 22		CL with MS n = 21		Total n = 43	
	Frequency	%	Frequency	%	Frequency	%
1. Gender						
Male	10	45.5	11	52.4	21	48.8
Female	12	54.5	10	47.6	22	51.2
2. Mathematical Ability						
A (95-100)	3	13.6	2	9.5	5	11.6
A- (90-94)	4	18.2	4	19.0	8	18.6
B (85-89)	4	18.2	5	23.8	9	20.9
B- (80-84)	3	13.6	4	19.0	7	16.3
C (75-79)	5	22.7	2	9.5	7	16.3
D (75 below)	3	13.6	4	19.0	7	16.3

Legend:

A (95-100)	Excellent
A- (90-94)	Very Good
B (85-89)	Good
B- (80-84)	Satisfactory
C (75-79)	Fair
D (75 below)	Poor

Levels of Mathematics Performance before and after Instruction when exposed to CL with MS and CL only

Table 3 shows the mathematics performance of pupils when exposed to CL with MS and CL only. The pretest mean of CL with MS group is 18.33 (62%) while that of CL only group is 18.77 (63%). Although before conducting the experiment the CL only performed higher compare to the CL with MS, both of the group is poor in their mathematical ability. The posttest mean of CL with MS group is 34.76 (82%) while that of CL only group is 33.73 (80%) and there mathematical ability is satisfactory. This implies that after the experiment the CL with MS group performed higher compare to the CL only group. Therefore, the cooperative learning method is inadequate without metacognitive scaffolding or, cooperative learning with metacognitive scaffolding method is superior to cooperative learning method alone.

Table 3. Level of the mathematics performance of pupils before and after instruction when exposed CL with MS and CL only.

	Pretest				Posttest			
Group	Mean	SD	%	Qualitative	Mean	SD	%	Qualitative
CL with MS	18.33	7.844	62	Poor	34.76	9.104	82	Satisfactory
CL only	18.77	7.483	63	Poor	33.73	10.776	80	Satisfactory

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Table 4 presents the comparison of the posttest mean gain scores of the two groups in the posttest and pretest was 16.429 for the pupils exposed to cooperative learning with metacognitive scaffolding and 14.955 for cooperative learning only. The result of pretest and posttest shows a significant probability value of 0.000. Both groups showed significant difference in their gain scores. This implies that the strategy in each group increase the mathematics performance of the pupils. The cooperative learning with metacognitive scaffolding method is based on cognitive theories of learning that emphasize the important role of elaboration in constructing new knowledge (Wittrock, 1986), and on a large body of research (e.g., Davidson, 1990; Qin et al., 1995; Stacey and Kay, 1992; and Webb, 1991, 1989a) showing that cooperative learning has the potential to improve mathematics performance because it provides a natural setting for students to supply explanations and elaborate their reasoning. Thus, the use of metacognitive scaffolding helped the pupils to fully benefit from cooperative learning.

Table 4. Mean scores of difference in the achievement posttest – pretest of the pupils exposed to CL with MS and CL only

GROUP	MEAN		GAIN	SD	T-VALUE	PROB> /T/
	Pretest	Posttest	Posttest - Pretest			
CL with MS	18.33	34.76	16.429	7.633	-9.864	0.000*
CL only	18.77	33.73	14.955	8.426	-8.325	0.000*

*significant at .05 level

Significant Difference in the Mathematics Performance exposed to CL with MS and CL only when Grouped According to their Profile

Table 5 shows the comparison of mathematics performance when grouped according to gender. Both groups showed no significant difference in their mathematics performance. This implies that male and female performed comparably in Grade VI Mathematics. This finding contradicts the findings of the study of Bacabis (2000) and Carmelo (2008). Bacabis (2000) reported that females apply a great number of ways and strategies compared to males. On the other hand, in the study of Carmelo (2008), she stated that the picture for boys in mathematics is less complicated. Boys of all ages and races are scoring as high – or higher – in mathematics than ever before. While these studies are proven true, they may vary in different problems.

Table 5. Comparison of mathematics performance when grouped according to gender.

Group	Gender	Mean	SD	t-value	p-value
CL with MS	Male	32.73	10.209	-1.078	.294ns
	Female	37.00	7.601		
CL Only	Male	34.10	12.270	.145	.886ns
	Female	33.42	9.913		

ns – not significant at .05 level

Table 6 shows the comparison of mathematics performance when grouped according to mathematical ability. In CL with MS group, the mathematical ability excellent is comparable to very good but not to good, satisfactory, fair and poor; very good is comparable to excellent and satisfactory but not to good, fair, and poor; good is comparable to satisfactory and fair but not to excellent, very good, and poor; satisfactory is comparable to very good, good, and fair but not to excellent and poor; fair is comparable to good, satisfactory, and poor but not to excellent and very good; poor is comparable to fair but not to excellent, very good, good, and satisfactory. In CL group, the mathematical ability excellent is comparable to very good but not to good, satisfactory, fair, and poor; very good is comparable to excellent and good but not to satisfactory, fair, and poor; good is comparable to very good and satisfactory but not to excellent, fair, and poor; satisfactory is comparable to good and fair but not to excellent, very good and poor; fair is comparable satisfactory and poor but not to excellent, very good, and good; poor is comparable to fair but not to excellent, very good, good, and satisfactory.

For CL with MS, the f-value is 7.741 and p-value is .001 while that of CL only the f-value is 9.389 and p-value is .000. Thus, majority of the mathematical ability showed significant difference in their mathematics performance at 0.001 level. This means that the mathematical ability of a pupil will either increase or decrease the mathematics performance.

Table 6. Comparison of mathematics performance when grouped according to mathematical ability.

Treatment Group		Mean	F-value	P-value
	Excellent	48.00		
	Very Good	43.25		
CL with MS	Good	33.20		
	Satisfactory	35.50	7.741	0.001
	Fair	28.50		
	Poor	24.00		
	Total	34.76		
	Excellent	46.67		
	Very Good	43.50		
	Good	36.00		
CL only	Satisfactory	32.67	9.389	0.000
	Fair	24.80		
	Poor	20.67		
	Total	33.23		

*significant at .01
**significant at .001

The pupils under cooperative learning with metacognitive scaffolding showed significant difference on their mathematics performance.

The findings on cooperative learning with metacognitive scaffolding support the hypothesis that cooperative learning with metacognitive scaffolding improves mathematics performance as shown by studies of Schoenfeld (1985).

Cooperative learning with metacognitive scaffolding method enabled students to acquire the appropriate procedural problem solving techniques, and therefore, they were able to maneuver the computations more accurately than the students in the other group.

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Difference between the Mathematics Performance of Pupils when exposed to CL with MS and CL only

Table 7 shows the effect of the test between groups using analysis of covariance (ANCOVA) wherein the total score of posttest was the dependent variable and the total score of the pretest is the covariate. The alpha level is set at the 0.05 level.

The grouping is the two strategies, (1) Cooperative Learning with Metacognitive Scaffolding and (2) Cooperative Learning Only. The result of F-test does not support the effect of the strategies on pupil's mathematics performance after controlling of total score of pretest F(1,41) = 24.285. Using the pretest as covariate, the two groups is significant (F = 36.171, p = 0.000), meaning the groups were comparable at the start; this difference has been spelled out by ANCOVA, hence there is significant results in the post test. Thus, the null hypothesis stating that "there is no significant difference between pupils' mathematics performance when exposed to CL with MS and CL only" is rejected. A close examination of the results revealed that cooperative learning alone is insufficient as a form of scaffolding. It is evident that cooperative learning with metacognitive scaffolding method is effective in supporting pupils' mathematics performance.

This finding is supported by the study of Tan (2009) which develop a framework on Mathematical problem solving heuristics among students. She found out that students use metacognitive skills in the problem solving process and this metacognition would facilitate better performance. As in this study, the teacher using metacognitive scaffolding modelled the students on how they should process information at hand to solve the problem. This also support the fact that cooperative learning alone do not guarantee increase in performance among pupils especially if they were just left on their own. The guidance of a teacher through metacognitive scaffolding proves to be effective.

Table 7: ANCOVA results of pupil's mathematics performance when exposed to CL with MS and CL only using pretest as covariate.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1527.993(a)	1	1527.993	24.285	0.000**
Group	1020.616	1	1020.616	10.322	0.043*
Pretest	1527.993	1	1527.993	24.285	0.000**
Error	2579.682	41	62.919		
Total	54498.000	43			
Corrected Total	4107.674	42			

**significant at .0001 level
*significant at 0.05 level

Difficulties of Pupils in Grade VI Math

Table 8 shows the frequency distribution of the difficulties of the pupils in Grade VI Mathematics. The difficulties are summarized into five entries: understanding the concept, analyzing the problem, memory problems, math anxiety/attitude problem and lack of basic math skills.

Table 8: Difficulties of pupils in Mathematics

Difficulties in Math	Cooperative Learning Only n = 22		Cooperative Learning with Metacognitive Scaffolding n = 21	
	Frequency	%	Frequency	%
Understanding the concept	7	31.81	3	14.29
Analyzing the problem	5	22.72	6	28.57
Memory Problems	3	13.63	5	23.81
Math Anxiety/ Attitude Problem	4	18.18	5	23.81
Lack Mastery of Basic Math Skills	3	13.63	2	9.52
Total	22	100	21	100

As shown on table 8, most of the pupils in CL only group has difficulty in understanding the concept while in the CL with MS is difficulty in analyzing the problem.

The effectiveness of CL with MS method on mathematics performance that consists of conceptual understanding and procedural fluency support King and Rosenshine's (1993) study that found that guidance through questioning enhances problem representation and improves conceptual understanding. The metacognitive questions have provided the students with cues to important aspects of the problem and helped them to identify the problem and identify relevant and important information. While conceptual understanding is enhanced by constructing relationships between the previous and the new knowledge (Kilpatrick et al, 2001), the CL with MS method encouraged students to identify the similarities and differences between the problem at hand and the problems solved in the past. The findings of this study are consistent with studies by Schonfeld (1987) and Xun (2001) that questioning strategies enabled students to connect what they learned with their current learning situation. Metacognitive questions helped students to make connections between different factors and constraints and link to the solutions. In this regard, metacognitive questions assisted students to enhance their understanding of a given domain knowledge.

Conclusion

On the basis of the findings of the study, the following conclusions were drawn:

The number of male pupils is almost equal in the number of females. The mathematical ability of the pupils ranges from excellent to poor and the number of pupils varied in each treatment group.

The mathematics performance of pupils before and after instruction when exposed to CL with MS and CL only increased. In terms of pretest mean, the CL only group is higher compared to CL with MS. In terms of posttest mean, the CL with MS group is higher compared to CL only.

The result of pretest and posttest showed significant difference in their gain scores. The mathematics performance of pupils showed considerable increase after being exposed to CL with MS and CL only group.

Male and female are comparable in their mathematics performance. On the other hand, pupils with varied mathematical ability differ significantly on their mathematics performance.

The CL with MS and CL only group differ significantly or are comparable at the start. There is a significant result in the posttest of the two groups.

Grade 6 pupils have varied difficulties in Mathematics. In CL with MS group, majority of them had difficulties in analyzing the problem followed by memory problems, math anxiety/attitude problems then mastery of basic math skills. In CL only group, majority of them had difficulty in understanding the concept followed by analyzing the problem, math anxiety/attitude problem, then memory problem and lack mastery of basic math skills.

Suggestions and Recommendations

Based on the findings of the study, the following recommendations are given:

Teachers are encouraged to use activities that will enhance or improve the mathematical ability of the pupils. They may use creative strategies in the mathematics teaching.

Pupils can be exposed to CL with MS as it enhances their mathematics performance. The implementation of cooperative learning with metacognitive scaffolding method is not costly. Therefore, the effectiveness, the high learning ability level and the cost effectiveness of this method make this method a good candidate for inclusion in the development of the pedagogical approach.

Metacognitive scaffolding can be integrated in instructional design, curriculum design, and computer based design to develop mathematics performance, metacognitive knowledge and facilitate self-regulated learning.

Teachers who have been using cooperative learning and metacognitive scaffolding will continue using it since it gives no significant difference in the gender but in their mathematical ability. The cooperative learning with metacognitive scaffolding method should be included in teacher education programs.

The use of metacognitive scaffolding may be used in order to help pupils to fully benefit from cooperative learning.

Varied mathematical activities can be integrated in the classroom to lessen the difficulties of the pupils. There are several skills, such as grouping, drawing metacognitive questions, and reflection, that pre-service and in-service teachers need to be trained. Also the use of cooperative learning with metacognitive scaffolding method in the classroom requires an approach to assessment and evaluation that is different from the present system. A more authentic and performance-based assessment criteria, that pre-service and in-service teacher need to be trained to develop to accompany the implementation of this method in the classroom.

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