Original Article

Impactful Cooperative Learning and Academic Achievement of Mathematics Students

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Abstract

Most mathematics abstract concepts have difficulty teaching-learning, but it is easy to utilize appropriate teaching techniques like cooperative learning for better academic achievements. The current study aimed to examine the impact of cooperative learning on mathematics students’ academic performance in grade 5. Fifty students were employed as an experimental group. The data were collected through a developed questionnaire at two points, that is, pre-test and post-test. The test was based on subjective and objective methods that have multiple-choice questions (MCQs) covering the cognitive domain of Bloom’s Taxonomy. The MCQs were distributed among three domains with nearly equal weighting given to knowledge, understanding, and application (or problem-solving) skills. Data were analyzed through statistical methods that determined the positive impact of cooperative learning on the academic achievement of mathematics students. The involved students found it pleasant and enjoyed the learning environment. Teaching through cooperative learning is recommended as designing activities that promote group work can help students for better academic achievement.

Keywords: academic achievement, cooperative learning, mathematics, primary education

INTRODUCTION

The concept of cooperative learning is one of the successful pedagogies that can improve students’ academic performance. This is to assist each group member’s success and is linked to completing a task to enable students to get their desired objectives, share their ideas, provide resources, and put in the effort (Hossain & Tarmizi, 2013). Mathematics is one of the core science subjects that requires more thinking and problem-solving skills and has a wide use in many fields; therefore, it is important to teach the students in such a way that they can understand effectively for better academic achievement by focusing more on teaching strategies (Lynch & Mancenido, 2023). Mathematics subject is considered boring and difficult impact of cooperative learning is proven as an effective way of learning. Raviv, et al., (2019) claim that success can be achieved by students in mathematics if they are given opportunities to develop their self-confidence and communicate mathematically to solve problems. According to (Razak, 2016), it also works on the effect of alternative instructions on mathematics achievement. Thus, critical assumptions generate support to achieve targeted objectives. The current study has the following objectives:

Research Objectives

• To differentiate pre-test and post-test results of mathematics students.
• To examine the impact of co-operative learning approach on the academic achievement of mathematics students after implementing cooperative learning.

Research Questions

• What is the difference in results after the implementation of cooperative learning?
• What is the impact of cooperative learning on mathematics students’ academic achievement?

Research Hypotheses

H₁ There is no significant difference after implementing cooperative learning for mathematics students
H₂ There is no significant impact of cooperative learning on the academic achievement of Mathematics students

LITERATURE REVIEW

The cooperative teaching-learning technique is impactful and helps to engage students in mathematics classes as it reduces the unpleasant environment and increases students’ interest. Student-centred approach improves mathematics achievement and attitude toward mathematics learning among school students (Yassin, et al., 2018). Therefore, the mathematics teachers must be aware of students’ needs and how teaching practices have changed recently. Cooperation gives positive change when it takes place effectively incorporating student centred approach, but it can be successful when the teacher applies mastery in cooperative learning. Studies have found that mathematics enables us to express the concepts and relationships derived from our surroundings (Kitta, 2004). The awareness in students who are passive during their class sessions become actively engaged. The use of cooperative learning has became popular at the school side and teachers are
Cooperative learning is always supported to enhance academic achievement that encourages better understanding as compared to traditional teaching techniques (Parveen, Youset al., 2017). It has an impact on other subjects like language as well and supports fluency in language communication. Implementing cooperative techniques and student-centred classes can have optimal for fluency development (Namaziandost, et al., 2020). It has a good impact on self-directed learning abilities using computer applications in class and affects students’ perceived readiness for self-directed learning skills (Mentz & Van Zyl, 2018). Nonetheless, the application of cooperative learning technique allows interaction among students and gives space to pair-share and demonstration. This gives better results as compared to traditional methods and students’ attitude towards mathematics improves and motivates the learners. Using cooperative learning techniques, students take an instructional approach positively to learning mathematics (Ahmadi, 2000).

Computer programming is often to enhance learning where the use of the jigsaw technique is a valid and effective teaching strategy that handles novice programs (Garcia, 2021). Such strategies also assist pupils in engaging themselves by decreasing negative emotions. These emotions do not have gender differences and may equally engage them in learning (Qin, et al., 2020). This technique is found to encourage students’ interpersonal skills and motivates them towards the learning process, which also impacts the attainment of a series of academic targets (Mendo-Lázaro, et al., 2022). The application of cooperative technique brings significant changes to improve students’ results (Wu & Tao, 2022). It is a good form of a team work as well that develops a better attitude in students at the school level (Reinhard, 2021). The basic agenda of the technique is to help children develop literacy and numeracy skills, which help them to participate in the society. Overarching goal of cooperative learning is to help children enabling them to encompass a wide range of educational outcomes where students centred approach helps to develop their cognitive level (Trinidad, 2020). Keeping this in mind, it has one common agenda of reflecting intellectual pursuits that are based on students’ competencies (Steinmayr, et al., 2018).

Cooperative Learning and Teaching Strategies

Cooperative learning has been used as a teaching method at all levels of education and in a wide range of subject areas. It is an instructional approach, which represents a shift from the traditional approach to a highly student-centred approach in education. Cooperative learning is all about group work, where students can share their ideas and complete their tasks. Different teaching modules are linked with contextual factors that vary to a great extent (Supena, et al., 2021). For example, in the Students Teams Achievement Division (STAD) where students are asked to distribute into mixed groups as per their ability, gender, and ethnicity. The materials are distributed among the groups by the instructors and the students work together until all have mastered the lesson. Individual quizzes are conducted and the team scores as much as they have performed as compared to their previous performance. The other model is jigsaw method in which the students support one another in groups and the mentor divides the task amongst them by assigning a special status with the group. By using STAD as a paradigm, (Arfin, 2022), investigated the influence of cooperative learning where the majority of students found a favourable opinion of STAD. Abd Algani (2021), also experienced that the group had good views about mathematics subjects. Meanwhile, this study pointed out the positive impact of cooperative learning on mathematics achievement.

**METHODOLOGY**

The study used an experimental research design to examine the impact of cooperative learning on mathematics students. The study targeted to find out a link between two variables of cooperative learning and academic achievement of mathematics students. Grade 5 students in the public sector were selected as the population, while 50 students were selected using a random sampling technique giving equal opportunity to both genders. For data collection purposes, a self-developed questionnaire (pre-test and post-test) was used to examine impactful learning through a cooperative learning approach in mathematics class. The pre-test consisted of 20 multiple-choice questions (MCQs) based on basic cognitive levels of Bloom’s taxonomy (7 MCQs of Knowledge, 7 MCQs of Application and 6 MCQs of Creation), with equal weightage given to knowledge, application, and creation (or problem-solving) skills; while for the post-test, the same topic was included in the questionnaire with modification. The author spent four months teaching ten lessons before and after cooperative learning. To ensure the validity of the questionnaire, the questions were provided for both tests from the mathematics textbook of grade 5. All questions were designed according to the actual purpose of the study and were reviewed by mathematics experts.
The data were represented in tabular form and descriptive analysis was used. The data collected from the pre-test and post-test were coded using Statistical Package for the Social Sciences (SPSS-24), where two types of analysis were run. Secondly, inferential analysis, and independent sample T-test was run to identify the difference between the results of pre-test and post-test. Another significant aspect of the research was the ethical consideration by following careful steps. The participants’ personal information was not shared and there was no misinterpretation or misuse of data. The findings were presented straight forwardly and objectively.

RESULTS AND FINDINGS

Students’ results before the implementation of cooperative learning show a significant difference. The scores of the mean of mathematics students were calculated in various stages of learning. Based on mean scores, SD, and minimum and maximum scores, pre-test results of all major domains were found. The pre-results of the three stages were calculated; Table 1 examined students’ performance before implementing cooperative learning.

Table 1
Pre-test Result of three major stages of Bloom Taxonomy

<table>
<thead>
<tr>
<th>Pretest of Knowledge</th>
<th>Pretest of Understanding</th>
<th>Pretest of Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>3.80</td>
<td>3.88</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>1.604</td>
<td>1.438</td>
</tr>
<tr>
<td>Minimum</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Maximum</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 2 shows the examined normality of the data. It shows Shapiro-Wilk test statistic testing data for dispersion. As per the table, the data were found abnormally distributed, if the p-value is below 0.05. In this case SPSS output, the p-value is labelled as SIG, which shows that the p-value for various dependent variables is above 0.05 in the pre-test, but for the post-test p-value is below 0.05. The Shapiro-Wilk test thus indicates that data was not normally distributed.

Table 2
Data Normality

<table>
<thead>
<tr>
<th>Kolmogorov-Smirnov</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistic</td>
<td>Df</td>
</tr>
<tr>
<td>Total Result of Pre test</td>
<td>.176</td>
</tr>
<tr>
<td>Post Result Total</td>
<td>.268</td>
</tr>
</tbody>
</table>

Table 3 indicates the results after the implementation of cooperative learning based on mean scores, SD minimum and maximum scores, post-test results of three domains were found. The post-results of the major three stages of Bloom’s taxonomy were calculated as given below:

Table 3
Post-Test Results

<table>
<thead>
<tr>
<th>Posttest of Knowledge</th>
<th>Posttest of Understanding</th>
<th>Posttest of Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.04</td>
<td>3.90</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>1.456</td>
<td>1.460</td>
</tr>
<tr>
<td>Minimum</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Maximum</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 4 indicates a significant difference after inferential analysis to determine if the two sample population mean ranks differ. Wilcoxon signed-rank test was used to compare related samples and matched samples for paired difference test of repeated measurements on a single sample. The purpose of using this test was to check null hypothesis because the data were not normally distributed.
Table 4
Difference between mean

<table>
<thead>
<tr>
<th>Post Result Total - Total Result of Pre test</th>
<th>N</th>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative Ranks</td>
<td>7</td>
<td>17.00</td>
<td>119.00</td>
</tr>
<tr>
<td>Positive Ranks</td>
<td>25</td>
<td>16.36</td>
<td>409.00</td>
</tr>
<tr>
<td>Ties</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5 shows p-value as .005. The result is significant at p<.05. Therefore, Wilcoxon signed ranks test indicates that there is a positive impact of cooperative learning.

Table 5
Post Result Total - Total Result of Pre test

<table>
<thead>
<tr>
<th>Post Result Total - Total Result of Pre test</th>
<th>Z</th>
<th>Asymp. Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-2.798</td>
<td>.005</td>
</tr>
</tbody>
</table>

A significant value of .005 shows that the null hypothesis was rejected which means there is a significant difference between pre-test and post-test results. It shows that there is a significant difference after the implementation of cooperative learning. Table 6 indicates that to see the relation between variables, pair-T test was used that showed the relation between the variables in which mean, number of the sample, Std. deviation, and Std. error means are shown below. The mean value of the total results of the pre-test is 9.84 (SD: 2.675), while the mean value of the total results of the post-test is 10.42 (SD: 2.442) suggesting that there is a significant result after the implementation of cooperative learning within mathematics classroom.

Table 6
Paired Sample Statistics

<table>
<thead>
<tr>
<th>Pair 1</th>
<th>Total result of Pre-test</th>
<th>9.84</th>
<th>50</th>
<th>2.675</th>
<th>.378</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total result of Post-test</td>
<td>10.42</td>
<td>50</td>
<td>2.442</td>
<td>.345</td>
</tr>
</tbody>
</table>

Table 7 shows the paired sample correlation of both pre-test and post-test results having two variables cooperative learning and mathematics achievement. The correlation between the two variables is .863, which is a positive value which means both variables are correlated positively. This means that if there is a high implementation of cooperative learning within the classrooms, the mathematics result of the students might be improved. The Sig. value is 0.000 which is a positive sign as the value of significance is less than 0.05 (Typically ≤ 0.05) then it is statistically significant.

Table 7
Paired Samples Correlation

<table>
<thead>
<tr>
<th>Pair 1</th>
<th>Total result of Pre-test and post-test</th>
<th>N</th>
<th>Correlation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total result of Pre-test and post-test</td>
<td>50</td>
<td>.863</td>
<td>.000</td>
</tr>
</tbody>
</table>

Discussion
The findings of the current study show that there is a positive impact of cooperative learning on the academic performance of mathematics students and cooperative learning implementation has improved their academic performance. Cooperative learning provides students with support of their classmates, who can help them out any time they need. The first question on what is the difference in results after the implementation of cooperative learning shows that cooperative learning changed the results and improved the academic results. Another question about the impact of cooperative answered that there is a positive impact of cooperative
learning on the academic performance of the students in mathematics education. On another hand, the first null hypothesis has been rejected and found that there is a significant difference after the implementation of cooperative learning. Moreover, the second hypothesis is also rejected and found that there is a significant impact of cooperative learning on mathematics students’ academic performance. Therefore, it is suggested that cooperative learning is a better method than traditional teaching methods because students worked within groups as a team and help each other in the whole process of learning. The students learn how to work as teams to achieve a single goal. These results support the concept of cooperative learning usage within classrooms (Ridwan, et al., 2021). It is seen that cooperative learning impacts positively on the academic performance of mathematics students (Zhu & Kaiser, 2022). Cooperative learning refers to small, group-based instruction in which students work together to achieve a learning goal and it gives affective results (Rahmatwati, et al., 2023). The results of the study support this concept of group work because during the process of intervention process, grouping was one of the main key elements through jigsaw activities that impacted positively on students’ academic performance (Abed, et al., 2019). The results of this study support that students get their desirable results helping each other, sharing their ideas, providing resources and using motivating efforts. This research also supports the current study because, during the intervention process, the teacher motivated the students to work together to share their ideas by providing them with resources to get good results (Ambussaidi & Yang, 2019).

CONCLUSION & RECOMMENDATIONS

The current study found a positive impact of cooperative learning on the academic performance of mathematics students in grade 5. The study found that there is an improvement in the academic performance of the students because cooperative learning provides students with the support of their classmates, who can help them out any time they need. The results indicated that there is a positive impact of cooperative learning on the academic performance of the students. Through such a strategy, each group member is responsible to share his work performance to solve the given mathematical problem. Applying Bloom’s Taxonomy aimed to examine students’ learning to improve their cognitive levels by shedding some light on the effectiveness of cooperative learning. In addition, through such interaction, students constructed knowledge in the sense that they competed and enjoyed their learning by spending their time doing the assigned activities. Finally, its practical implication is recommended at the primary level to enhance mathematics students’ results.

Competing Interest

The authors have declared no competing interest.

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