Asian Journal of Advanced Research and Reports

16(11): 37-48, 2022; Article no.AJARR.91640
ISSN: 2582-3248

Effect of Co-operative Learning Approach on Students' Achievements in Solving Word Problems Involving Fractions

Evans Atteh [a*] and Matthew Adusei [b]

[a] Department of Mathematics and ICT, Wiawso College of Education, Sefwi Wiawso, Ghana.
[b] Department of Mathematics, Adventist Senior High School, Kumasi, Ghana.

Authors' contribution

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJARR/2022/v16i11437

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/91640

Original Research Article

Received 05 August 2022
Accepted 10 October 2022
Published 18 October 2022

ABSTRACT

Despite the concerted efforts of teachers to enhance learning of mathematics among senior high students, performance and success in learning mathematics is still unsatisfactory. Based on this, the study aimed at assessing the effect of cooperative learning on the achievement of students of Adventist Senior High School, Kumasi when solving word problems involving fractions. Quasi-experimental design was used for this study. Sample size for this study was 158 second year (track gold) students. Purposive sampling was employed to select the second year students in the Business (2B2 & 2B3) and General Arts (2Arts1 & 2Arts3) classes. The instruments for data collection were test items and interview. The study used pre-test and post-test word problem questions to gather information from the students and an interview was conducted afterwards. The findings showed that the pre-test mean score of students was lower than the post-test scores of students in both the experimental group and control group. The findings showed that the effectiveness of the cooperative learning approach was positive in solving word problems involving fractions. The study found a significant difference in the performance of students who were taught by using cooperative learning in the experimental group and those students who were taught with the conventional methods in the control group ($t=7.759$, $p=0.000<0.05$). The study concluded that the cooperative learning approach improved students' academic performance. Due to the effectiveness of learning through co-operative approach, students wish it would be used in teaching other subjects. It was recommended that mathematics teachers should adopt the cooperative learning approach in the teaching and learning of other topics in mathematics.

**Corresponding author: Email: atteh1984@gmail.com;*

Keywords: Cooperative learning; fraction word problems; teaching and learning math; mathematical problems.

1. INTRODUCTION

Greater demands have been placed on people's capacity to analyze and use mathematics to make sense of information and complex situations in today's technology-driven culture. Everything in our daily lives is built on it, including mobile technology, historical and contemporary architecture, art, commerce, engineering, and even sports [1]. According to Golding [2], mathematics comprises proving theorems, creating geometric constructs, establishing patterns, examining statistics, and solving word problems, all of which are very helpful in solving difficulties that arise in daily life. Math is one of the key courses that students are expected to get at least credit (C6) to continue their studies in institutions of higher learning because of its relevance [3]. As a result, mathematics is one of the disciplines that are most crucial for student success.

The study of word problems is one area of mathematics that permeates all stages of education, according to a careful examination of the intended curriculum (syllabus) of Ghanaian schools. Thus, a lack of proficiency in word problems using fractions can eventually have an impact on students' learning in related fields of study and other areas of mathematics. It is commonly recognized that mastering other mathematical ideas, such as data handling and probability, money and taxes, algebraic expressions, geometry and trigonometry, measurement, volume and area, calculus, and so forth, requires a grasp of word problems. The complex mathematical concepts will be simpler to learn if you have a solid basis in the fundamental concepts used in word problems.

Although a word problem is not a separate topic in the mathematics curriculum, every topic in mathematics incorporates word problems [4]. However, a requirement for solving mathematical problems is learning to comprehend sufficiently well to interpret the meanings embedded in the context of a word problem [5]. Mathematical word problems, often known as story problems, have long been a staple of education. The conversion of word problems into arithmetic or algebra presents significant challenges for many pupils [6]. There have also been studies that have examined mathematical word problems in terms of students' challenges with their readability (that is, the linguistic factors that make them easier or harder to read and understand), as well as students' ease or difficulty in translating them from "normal language" to mathematical symbolism [6,7], indicating that students face a variety of challenges when dealing with word problems. According to the West African Examination Council's chief examiner's report [8,9] on student performance in the West African Secondary School Certificate Examination (WASSCE) in mathematics (core), the majority of candidates avoided word problem questions, and the few who attempted them were unable to accurately solve the problem because they did not know the approach needed to solve the problem.

In some cases, teachers still fail to introduce the notion of fractions to their students in this crucial area of mathematics. Teachers who make an effort to teach do so without incorporating any techniques that will help their students comprehend the concept better or even more efficiently. Students' low accomplishment levels in both internal and external tests, as well as their aversion to learning the subject, are indicators of how difficult it is to understand mathematics and, for that matter, word problems [10]. The level of student engagement in the mathematics lessons was low, according to a series of observations conducted by some of the teachers. An assessment of students' knowledge and understanding in word problems involving fractions showed abysmal performance with the majority of students giving out incorrect solutions. The majority of students achieved scores in the range of 30% to 50% on exercise in class and 10% to 45% on end-of-term exams. The students blamed their teachers' methods for teaching mathematics in the classroom for their poor performance.

According to research, improper teaching techniques are likely to blame for students' low performance on mathematics examinations [11]. Additionally, it was claimed by Udeinya and Okabiah [12] as well as Harbor-Peters [13] that the issue of subpar performance in math exams was brought on by a problem with teaching strategies that had affected the degree of desire for learning math. Likewise, there has been a growing understanding among individuals interested in mathematics education that the traditional approach to teaching mathematics has

not been very effective [14-16]. However, a good mathematics teacher will employ a variety of approaches and tactics at his disposal to deliver lessons that are effective. Cooperative learning is one of the numerous teaching strategies advocated by Johnson and Johnson [17], Slavin [18], and Ajaja and Mezieobi [19] that has a good impact on students' academic progress. In view of Jacobson and Baribor [20], cooperative learning stimulates students' learning interests, develops their capacity for exploration and creative thinking, and strengthens their sense of teamwork and social communication abilities.

According to Ghana's mathematics curriculum, teaching core mathematics in senior high schools is justified to build on the progress made in Basic School Mathematics and to raise standards of achievement by enabling all students to develop the mathematical knowledge, skills, insights, attitudes, and values they will need to succeed in their chosen career [21]. Moreover, there are other ways to educate and learn besides the typical classroom, where one person delivers the lesson and a group of learners observe, to accomplish this goal (Chin & Chia, 2004). Therefore, the study intended to investigate how students' academic performance in solving word problems involving fractions was affected by a cooperative learning strategy.

1.1 Purpose of the Study

This study aims to compare the performance of high school students who were taught using cooperative learning strategies with a control group who received tuition through traditional teaching methods when solving word problems involving fractions.

1.2 Research Questions

The following research questions were developed to guide the study:

1. What differences exists in academic achievement between students taught with the cooperative learning approaches and those taught using the conventional methods in solving word problems involving fractions?
2. What is the effect size of the cooperative learning approach in solving word problems involving fractions?
3. What are the views of students about learning through cooperative learning approaches?

2. LITERATURE REVIEW

Social constructivist theory served as the basis for this investigation. Social constructivism focuses on how an individual learns as a result of interactions and conversations inside and between groups. Studies contend that dialogue is essential for improving students' capacity to evaluate their own ideas, combine those of others, and develop a deeper comprehension of what they are studying [22,23]. Learners can also practice self-control, self-determination, and a drive to persevere with assignments through large and small group discussions [24]. Students who participate in group learning have more opportunity to interact with one another and exchange ideas, as well as to think critically, develop their reasoning abilities, and respectfully and eloquently defend their positions [25]. Furthermore, by giving students more opportunities to speak with one another in class, the sense of community and collaboration grows [27]. According to Jaworski [26], knowledge is socially anchored, and people create identities through social engagement (engagement here denotes active participation and mental inclusion). Therefore, it can be inferred that using teaching and learning techniques that promote constant engagement and interaction among students in the learning environment significantly enhances student learning outcomes [15,16,27-30].

Like in many other developing nations, mathematics instruction in Ghana was intense even during the colonial era, when religion teaching was prioritized in schools. Serebour [31] elaborates on the history of mathematics instruction during the colonial era, when arithmetic was included in the curriculum to enhance commercial activity. Therefore, it is not unexpected that mathematics is regarded as a core subject in Ghana and is an essential component of the country's school placement system in both basic school (primary and junior high school) and secondary school curricula. The high school curriculum in Ghana explicitly states that mathematics education is believed to be a necessary field of study and that everyone must acquire mathematical concepts and abilities to comprehend general information and participate actively in society [4,32].

The primary purpose of teaching mathematics, according to Serebour [31], is to make sure that all Ghanaian youth have the knowledge,

concepts, attitudes, and mathematical ideals necessary to thrive in their daily lives and vocations. However, students' ability in mathematics has developed into a significant danger concerning their ability to grow academically in Ghana. According to data from the West African Examination Council (WAEC), more than half of all students who took the mathematics exam in 2017 failed (WAEC, 2017). Anamua-Mensah, Mereku, and Asabere-Ameyaw [33] and Anamuah-Mensah, Mereku, and Ghartey-Ampiah [34] both lamented the poor performance of Ghanaian students, with low mean scores in international assessments, and suggested that the methods of instruction might contribute to the issue.

The cooperative learning approach is a teaching strategy where students work together to investigate an important question or produce a noteworthy product [35]. Oluwole and Muraina [35] went on to say that collaborative learning is what propels social constructivism, where students are ultimately in charge of their own learning and its final results. It promotes a cooperative learning style where students collaborate in teams to accomplish assignments, solve problems, or produce products. The cooperative learning approach, according to Gerlach [36], is predicated on the notion that learning is a naturally a social act in which the participants converse with one another and that it is via this conversing that learning occurs. Social learning, or learning in a group, is a crucial technique for students to practice, teamwork, and build critical thinking, self-reflection, and knowledge co-construction abilities. People who use collaborative learning, as opposed to individual learning techniques, use one another's resources and abilities by, among other things, exchanging knowledge and critiquing one another's work [37].

The improvement of performance, problem-solving abilities, attitudes, and values is central to the objectives of cooperative learning in any educational setting. According to Lawrence [38], a collaborative learning strategy boosts students' interest in math and invariably raises achievement. Similar research has demonstrated that in regard to solving mathematical problems, pupils who are taught with a cooperative strategy perform better than those who are taught with a conventional learning strategy [14]. In addition, a study by Zakaria et al. [39] on the effects of cooperative learning in comparison to more conventional teaching methods with students from a Miri school found that the cooperative learning strategy led to better achievement than the conventional teaching methods.

3. METHODOLOGY

3.1 Research Design

A quasi-experimental design was used for this study. A quasi-experimental design involves a non-random assignment of participants to two groups: experimental (treatment) and control groups [40]. The experimental group received the treatment (a cooperative learning approach), whereas the control group did not. The control group was used to establish a baseline for measuring achievement in this study. This design was used since the study was conducted in a classroom setting and it was not possible to assign subjects randomly to groups. This design was also used to make sure that no harm would come from giving or not giving services to someone in the sample.

3.2 Population, Sample and Sample Procedure

The target population for this study was students at Adventist Senior High School (ADASS). The accessible population was 1,808 students. Purposive sampling was used for selecting the target population of the study which were students from the second-year business and general arts classes. These second-year students have one year ahead of them to complete their programme and therefore will have more time to adjust to any change in the approach to teaching them mathematics. There are two hundred and seventeen (217) students in the second-year business and general arts classes. Simple random sampling was employed to select the study sample which was made up of 156 students, comprising of 82 general arts students (experimental group) and 76 business students (control group) for the study. Six volunteers from the class were interviewed. Students partaking in the interview were selected based on their performance in the post-test. The average age of the classes was sixteen (16) years and the students came from various regions in Ghana, comprising 78 males and 80 females.

3.3 Instrumentation

The instruments used were test items and an open-ended questionnaire. Each group (control

and experimental) was given a pre-intervention test or pre-test before the intervention and a post-intervention test or post-test after the intervention. The pre-test and post-test were each comprised of short word problem questions involving fractions. Equivalent mathematics achievement tests were used for pre-intervention and post-intervention treatment. After the post-test, the interview was conducted to determine the perception of students about learning through cooperative strategies.

3.4 Validity and Reliability

The researchers designed the pre-test and post-test and the questionnaire with reference to the purpose of the study. Secondly, the researcher gave a draft to experts at the University of Education, Winneba to check whether the items measure the intended purpose (face validity). The experts found out whether the items cover all research questions (content validity) and the extent to which the items measure specific constructs (construct validity). The examination of the items helped the researcher to reshape and reconstruct items that were not clear to the respondents.

A pilot study was conducted using the interview questionnaire and test items to test for reliability. The pilot study class was not involved in the final research study. From the feedback obtained after piloting, the study instruments were refined. After the pilot testing, Cronbach's alpha was used to estimate the reliability of students' questionnaires, which gave a value of 0.77, suggesting a good reliability instrument. This score represents a high level of instrument reliability that is deemed acceptable in research [41].

3.5 Data Collection Procedure

After administering the pre – test, students respective scores were recorded. The authors observed a generally low performance in the pre-test scores. To address these challenges of the students, a series of intervention activities using cooperative learning strategy were organized by the authors for the students and a post – test was administered to them. The intervention period was six (6) weeks. Their scores in the post-test were recorded for analysis. The researchers conducted interviews for the volunteered students to solicit their views on learning through cooperative strategies after the post-test. The outcome of the interview was recorded for analysis.

3.6 Intervention Activities

The content was taught to the experimental group through multiple activities and quizzes. The researchers adopted a model proposed by Atteh et al. [42], suggesting a five-step implementation of cooperative learning in the classroom. The study proposed that for effective cooperative learning implementation to occur, teachers are to teach the class in general, place the students into ability groups, provide exercises/assignments for the groups to discuss/solve for a solution, provide assistance to various groups when needed, and give an opportunity for each group to present its findings or solution for criticism or acceptance.

Several activities were designed to provide a cooperative learning experience for them. Each of these was followed by a quiz to evaluate group and individual performance after participating in each activity. There were four (4) major interventional activities which the students were taken through to grasp the concept of word problems.

1. Students were divided into ability groups through a selection process. Each group was assigned a sub-topic from a broad topic and tasked with preparing display charts explaining it in an explicit way. Each group presented their work in front of other groups for critique. A quiz was taken at the end of the lesson to check individual conceptualization.
2. The students were divided into ability teams through the previous method; they were then given a topic for discussion. The researcher kept on checking the discussion groups by providing the needed assistance where necessary. After this, a quiz was carried out, in which each member of the group was supposed to answer a single question. This rule was made to involve all learners in the learning process.
3. Each group was given sub-topics from the broad topic. They were allowed to discuss it for 20 minutes. After that, one member from each group, termed "expert," moved from each group to the other group and taught them the topic they were assigned. At the end, a quiz card was distributed to

each group to solve for checking their level of understanding.

4. The students were paired and were tasked to teach each other, a single topic was assigned to all groups. After 20 minutes, the pairs were exchanged and were again asked to share the knowledge they got. At the end, a quiz was administered to each group to check their level of conceptual understanding.

3.7 Data Analysis

The data that was collected from the SHS students were analysed using Statistical Package for Social science (SPSS) software version 23.0. Descriptive statistics, paired sample t-test, independent sample t-test, and one-way analysis (ANOVA) were used to analyze the data. The recorded interview was transcribed and the major issues emerged from the interview was analyzed and discuss.

4. RESULTS

The study produced quantitative data showing the scores of students in the pre-test and post-test. Students' achievement test scores were analyzed using inferential statistics. Specifically, the t-test was executed using the Statistical Package for Social Sciences (SPSS) version 23 software. The t-test was used to test for a statistically significant difference between the pre-test and post-test scores of the participants. For the analysis of scores, descriptive statistics (mean and standard deviation) were used.

The effect of teaching word problems involving fractions using a cooperative learning approach and those taught using the conventional method.

Table 1 presents the academic achievement of students taught with the cooperative teaching method (Experimental group) as well as those taught with conventional methods (Control group). The Table shows that the pre-test mean scores and standard deviation of the experimental group were 2.72 and 1.217, respectively. However, after the treatment was given, the mean and standard deviation scores rose to 4.84 and 1.760, respectively. The table further shows that in the control group, difference in the pre-test scores of students (Mean=2.55, SD=1.608) is lower than that of their post–test scores (Mean=2.90, SD =1.600). The findings showed that differences exist in mean scores in the pre-test and post-test scores within each group.

To determine whether the differences within each group are significant, a paired t-test was conducted at 0.05 level of significance as shown in Table 2.

As indicated in Table 2, the significant value for the cooperative teaching method was 0.00<0.05, which showed that the difference within this group was statistically significant. In addition, the conventional method had a p-value of 0.005<0.05, which showed a significant difference within this group as well. With a mean value of 2.148, the students in the cooperative group gained more than the students in the conventional group.

In determining whether a significant difference existed between group achievements, a paired t-test was conducted and the results are presented in Table 3.

Table 1. Mean achievement by teaching methods

Group	N	Pre-test		Post-test	
		Mean	Std. Dev.	Mean	Std. Dev.
Cooperative	82	2.72	1.270	4.85	1.760
Conventional	76	2.55	1.608	2.90	1.600

Source: Field Work using SPSS (2022)

Table 2. Statistical differences within group achievements

Group	Test	Mean	Std. Dev.	Std. Error Mean	T	df	Sig. (2-tailed)
Cooperative	Post-test - Pre-test	2.148	1.478	.142	15.108	107	.000
Conventional	Post-test - Pre-test	0.352	1.270	.122	2.879	107	.005

Note: p-value <5% (0.05) Source: Field Work using SPSS (2022)

Table 3. Statistical difference between group achievements

Test	Group	Mean	Std. Dev.	Std. Error Mean	T	Df	Sig. (2-tailed)
Pre-test	Cooperative – Conventional	0.157	2.024	.195	.808	107	.421
Post-test	Cooperative – Conventional	1.954	2.617	.252	7.759	107	.000

Note: p-value <5% (0.05) Source: Field Work using SPSS (2022)

Table 4. Tests of Between-Subjects Effects Size

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	120.078[a]	5	24.016	63.725	.000	.758
Intercept	707.413	1	707.413	1877.099	.000	.948
Cooperative learning	120.078	5	24.016	63.725	.000	.758
Error	38.440	102	.377			
Total	**948.000**	**108**				
Corrected Total	**158.519**	**107**				

a. R Squared = .758 (Adjusted R Squared = .746) Source: Field Work using SPSS (2022)

From Table 3, it can be seen that the p-value for the pre-test was 0.421>0.05, indicating an insignificant difference at the entry level. This shows that all students in both groups entered with almost the same level of knowledge. For the post-test, the p-value was 0.000<0.05, meaning that there was a significant difference in the achievements of students who were taught by using cooperative learning strategies (in the experimental group) and those students who were taught with the conventional teaching methods (in the control group).

The effect size of cooperative learning approach in solving word problems involving fractions: For the researchers to address the effect size of the cooperative learning approach in solving word problems involving fractions, a questionnaire concerning the effectiveness of cooperative learning was administered to the selected students and the responses were presented in Table 4.

The results in Table 4 show a statistically significant difference among all students' who were taught by using cooperative learning in the experimental group (F=63.725, P=0.000<0.01). The partial Eta^2 however, is 0.758 which shows a medium effect size of using cooperative learning approach in solving word problems involving fractions. According to Cohen's $D\eta^2$ = 0.20 indicates a small effect; η^2 = 0.50 indicates a medium effect; η^2 = 0.80 indicates a large effect. It also shows that R^2 was 0.758 which accounted for 75.8% of the variation in using cooperative learning. This implies that the effect size of using the cooperative learning approach to teaching students in solving word problems involving fractions is significant at 0.000<0.01 level.

The views of students about learning through Co-operative approach: Students general views about learning through co-operative approach in solving word problems involving fractions were collected through an open-ended interview after the post-test was conducted. The opinions of the five (5) students who participated in the interview were presented below.

View of one student was worthwhile:

> *Working alongside friends offered me the chance to express my opinions, which helped me better understand the topic.*
>
> *Co-operative learning techniques made it easier for me to retain the information learnt.* (Comment from Student A)

Another student stated that:

> *Co-operative learning techniques make lessons engaging and pleasant, thus I would love to see other subject teachers adopt them when teaching us.*
>
> *Due to the chance to collaborate with others, I enjoy co-operative learning techniques. These have also boosted my confidence to learn math.* (Comment from Student B)

A student also commented:

> *I have been able to understand this difficult topic more easily because of co-operative learning strategies. And, it has increased my confidence in math.*
>
> *I learned a great deal of lessons in class, including how to be supportive of others, respect friends, collaborate, and help others.* (Comment from Student C)

Another worthwhile comment from another student stated:

> *When math was taught using a co-operative learning strategy, I liked the lessons. Co-operative learning techniques kept me interested in the topic while also developing a passion for math.*
>
> *Co-operative learning is more enjoyable and allows for joint exploration with peers.* (Comment from student D)

Another student also commented that:

> *I felt more comfortable learning from my friends than the teacher, thus I retained more information when I was interacting with them.*
>
> *As I was working with peers during math class, I appreciated it. They pushed me to put in my all. Since learning math from peers are more enjoyable and engaging, I would adore doing so more often.* (Comment from student E).

The interview revealed students' positive attitudes toward learning through cooperative methods, including enjoyment, confidence-building, interest-development, better understanding of concepts, the desire to learn other subjects through cooperative methods, and improving active participation in lessons that improve subject performance.

5. DISCUSSION

From Table 1, it is clear that there are differences in the mean and standard deviation (SD) of students' scores in both pre-test and post-test with mean (2.55) and standard deviation (1.608) as against the mean (2.90) and standard deviation of (1.600) respectively for the control group while for the experimental group, the mean of 2.72 and standard deviation of 1.217 as against 4.84 mean and 1.760 standard deviation. In addition, the difference observed in the mean scores of students taught by cooperative learning in the experimental group and those students who were taught with the conventional methods in the control group is statistically significant as shown in Table 3 ($t=7.759$, $p=0.000<0.05$). Since p value is less than 0.05 ($p=0.000$), this is quite evident that those taught in the cooperative learning approach performed better in the mathematics achievement test, particularly in solving word problems involving fractions. This finding is consistent with quantitative research by Marton and Saljo [43], Frank [44], Andam et al. [14], Watts and Moore [45], Linchevski and Kutscher [46], Karali and Aydemir [47], Denbe [48], Olanrewaju [49], and Edekor and Agbornu [11], which came to the same conclusions about how using cooperative learning to engage students improved their learning outcomes. In light of this, the results proved that using a cooperative learning technique rather than teaching a lesson, the traditional way improves students' academic achievement. The involvement of the students in explaining and receiving explanations from peers may have contributed to the rise in student accomplishment by facilitating the students' understanding of the concepts. Cooperative learning provides more room and opportunities for students to communicate, solve problems, come up with solutions, share ideas, and support one another, whereas traditional teaching methods, which are teacher-based, give students fewer chances to communicate, solve problems, come up with solutions, and collaborate with peers.

The findings from Table 4 showed a medium effect size ($\eta^2 = 0.758$) of using cooperative learning approach in solving word problems involving fractions. This implies that the cooperative method of teaching enhances students' academic achievement in solving word problems involving fractions to some certain extent. According to a study by Zakaria et al. [39] with students from a school in Miri, cooperative learning techniques had some level of effect on students' performance when compared to more traditional teaching strategies. Effandi [50] discovered that using the cooperative technique was a better alternative to the conventional teaching strategy. The study also revealed that pupils who received cooperative learning instruction outperformed their peers in various academic areas.

Additionally, the results of the open-ended interview show that using cooperative learning techniques during teaching and learning sessions has benefits, including enhanced interest in learning, better conceptual understanding, and learning through collaboration, which led to better performance in the subject. The outcome is consistent with an earlier study by Carbonneau, Wong and Borysenko [51] which found that using teaching aids and cooperative learning methods enabled students to collaborate in groups, enhancing their ability to solve problems mathematically and cultivating a love of learning. Additionally, it helped students perform better and honed their analytical and critical thinking abilities [14,30,51]. The students who participated in the interviews demonstrated a good perception toward learning mathematics, stating that they enjoyed and were content to learn the subject utilizing cooperative learning strategies.

5.1 Major Findings

- ✓ There was a significant difference in SHS 2 students in post-test results in favor of the cooperative learning group over the control group in word problems involving fractions.
- ✓ The cooperative learning group achievements improved considerably in post-test better than their pre-test scores with medium effect size in word problems involving fractions.
- ✓ Cooperative learning strategy give students benefits such as enhancing their interest in learning, better conceptual understanding, and learning through collaboration, which lead to better performance in word problems involving fractions.

6. CONCLUSION AND RECOMMENDATIONS

The study came to the conclusion that the Cooperative Learning Approach has improved the students' performance in resolving fraction word problems. This is due to the fact that following the intervention, the academic performance of the experimental group's students differed more on average from that of the control group. It was found that students who learned fraction word problems through a cooperative learning technique outperformed those who learned them through traditional approaches. The study again concluded that there was a significant medium effect size of using a cooperative strategy in learning how to solve word problems involving fractions. Therefore, to improve student accomplishment, it is important to urge math teachers to adopt and adapt a suitable cooperative learning strategy in conjunction with other carefully chosen teaching strategies. In comparison to traditional methods of teaching and learning, the utilization of cooperative teaching and learning technique aids in students' better grasp of the content of mathematics. As a result, higher and better achievements could be made in the future, and the perception of mathematics as a challenging subject will decline.

Based on the findings of the study, the following recommendations were therefore made:

- ✓ Mathematics educators should incorporate cooperative learning strategies into their regular interaction with students to influence the future practices of pre-service teachers.
- ✓ The head teachers should co-ordinate to invite experts in the field to share their experience of using cooperative learning with mathematics teachers to ensure easy adoption and implementation of this approach to teaching.
- ✓ School authorities should make teaching and learning resources available to aid the implementation of a cooperative learning approaches in a practical way to reduce or eliminate the challenges in implementing cooperative learning methods.

CONSENT

As per international standard or university standard, Participants' written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Moursund Z. The effects of cooperative learning on students in a matriculation mathematics class [PhD thesis]. Bangi: Universiti Kebangsaan Malaysia; 2006.
2. Golding N. The role of visualization approach in attitude towards mathematics and success. Elem Educ Online. 2018:945-57.

3. Adejumo MY, Oluwole N, Muraina H. The Dynamics of Students Participation in Classroom: observation on level and Forms of Participation. Procedia Soc Behav Sci. 2015;59 (2012):61-70.
4. Ministry of Education Youth & Sports. Teaching syllabus for mathematics (senior high school). Accra, Ghana: Ministry of Education, Youth and Sports; 2007.
5. Chamot AU, Dale M, O'Malley JM, Spanos GA. Learning and problem-solving strategies of ESL students. Bilingual Res J. 1992;16(3-4):1-28.
6. Burton MB. Grammatical translation-inhibitors in two classic word problem sentences. For Learn Math. 1991;11(l):43-6.
7. Andam EA, Okpoti CA, Obeng-Denteh W, Atteh E. The constructivist approach of solving word problems involving algebraic linear equations: the case study of Mansoman Senior High School, Amansie West District of Ghana. Adv Res. 2015;5(1):1-12.
8. The West African Examinations Council. May/June Chief examiners' report on the West African Senior High School Certificate Examination for core mathematics. Accra: Wisdom Press; 2017.
9. The West African Examinations Council. May/June Chief examiners' report on the West African Senior High School Certificate Examination for core mathematics. Accra: Wisdom Press; 2018.
10. Mills ED, Mereku DK. Students' performance on the Ghanaian junior high school mathematics National minimum standard in the Effutu Municipality, Ghana. Afr J Educ Stud Math Sci. 2016;12(3):5-19.
11. Edekor LK, Agbornu S. Cooperative learning strategy and students performance in mathematics in junior high school in Hohoe Municipality, Ghana. Am J Educ Res. 2020;8(9):694-9.
12. Udeinya CS, Okabiah OS. Special methods of Teaching Science Subjects. Enugu: ABIC; 1991.
13. Harbor Peters VFA 2018. Unmasking Some Aversive Aspect of School Mathematics and Strategies for averting them. Inaugural Lecture: 5th July, 2018.
14. Andam EA, Atteh E, Obeng-Denteh W. The cooperative learning approach of solving word problems involving algebraic linear equations at institute for educational development and extension (IEDE). Winneba, Ghana: university of education. Journal of Mathematical Acumen and Research. 2016;1(1):1-11.
15. Gyan RK, Ayiku F, Atteh E, Adams AK. The effect of Constructivism on Students' Performance in Solving Mathematical Problems under Trigonometry. Asian J Educ Soc Stud. 2021;19(2):1-18.
16. Boadi A, Acquandoh E, Adams AK, Kpai H, Atteh E. Teaching algebraic word problems through constructivism: the real classroom evidence. Asian J Adv Res Rep. 2020;14(1):37-51.
17. Johnson DW, Johnson RT. Learning together and alone. London: Allyn & Bacon; 2019.
18. Slavin RE. Cooperative learning: theory, research, and practice. 2nd Ed. Boston: Allyn & Bacon; 2018.
19. Ajaja R, Mezieobi SA. Effect of cooperative learning strategy on students performance in social studies. Int J Educ Eval. 2018;4(9):96-104.
20. Jacobson BN, Baribor V. The effect of teaching techniques on achievement in integrated science: the cooperative learning dimension. J Educ Train Technol. 2012;3(1):57-64.
21. Ministry of Education. Teaching syllabus for mathematics (high school). Accra, Ghana; 2019.
22. Corden RE. Group discussion and the importance of a shared perspective: learning from collaborative research. Qual Res. 2001;1(3):347-67.
23. Weber K, Maher C, Powell A, Lee HS. Learning opportunities from group discussions: warrants become the objects of debate. Educ Stud Math. 2008;68(3):247-61.
24. Matsumura LC, Slater SC, Crosson A. Classroom climate, rigorous instruction and curriculum, and learners" interactions in urban middle schools. Elem Sch J. 2008;108(4):294-312.
25. Reznitskaya A, Anderson RC, Kuo L. Teaching and learning argumentation. Elem Sch J. 2007;107(5):449-72.
26. Jaworski B. Theory in developmental research in mathematics teaching and learning: social practice theory and community of inquiry as analytical tool. Paper presented at CERME 5 (Group 11) in Cyprus 2007; 2007.
27. Atteh E, Andam EA, Obeng-Denteh W, Okpoti CA, Amoako J. The problem solving strategy of solving mathematical problems: the case study of Esaase Bontefufuo

Senior High Technical School, Amansie West District of Ghana. Int J Appl Sci Math. 2014;1(2):40-5.
28. Atteh E, Appoh EA, Amoako J, Obeng-Denteh W, Wiafe F. The impact of using balance model in teaching linear equation. Arch Curr Res Int. 2017b;11(3):1-12.
29. Mensah YA, Atteh E, Boadi A, Assan-Donkoh I. Exploring the impact of problem-based learning approach on students' performance in solving mathematical problems under circles (geometry). J Educ Soc Behav Sci. 2022;35(9):35-47.
30. Tshering N, Dorji T. Enhancing grade six students' mathematics achievement through the use of cooperative learning strategy: an action research. Asian J Educ Soc Stud. 2022;31(1):31-9.
31. Serebour OKS. Factors teachers, students and parents perceive as influencing JHS students' mathematics learning [MPhil thesis]. Ghana: UCC; 2013.
32. Curriculum research and development division (CRDD). National syllabus for mathematics (junior high school 1-3). Ghana: Ministry of Education; 2012
33. Anamuah-Mensah J, Mereku DK, Asabere-Ameyaw A. Ghanaian Junior Secondary School Students' Achievement in Mathematics and Science: results from Ghana's participation in the 2003 Trends in International Mathematics and Science Study, Accra. Ministry of Education, Youth and Sports; 2005.
34. Anamuah-Mensah J, Mereku DK, Ghartey-Ampiah J. TIMSS 2007. Ghana report. Findings from IEA's trends in international mathematics and science Study at the eighth grade. Accra: Ministry of Education; 2008.
35. Oluwole DA, Muraina KO. Effectiveness of motivational enhancement therapy in enhancing mathematics learning gains among school-going adolescents in Oyo State, Nigeria. Pac J Sci Technol. 2016;17(1):140-51.
36. Gerlach A. Collaborative learning enhances critical thinking. J Technol Educ. 2014;7(1):1045-1064.
37. Chiu N. Cooperative learning in mathematics: A handbook for teachers. Reading, MA: Addison & Wesley; 2014.
38. Lawrence R. Teaching data structures using competitive games education. J Compet Learn. 2014;47(4):459-66.
39. Zakaria E, Williams RB, Iksan Z. Promoting cooperative learning in science and mathematics education: A Malaysian perspective. Eurasia J Math Sci Tech Educ. 2010;3(1):35-9.
40. Campbell DT, Slanley JC. Experimental and quasi experimental design for research. Chicago: Rand McNally College Publishing Co; 1966.
41. Salifu AS. The geometric thinking levels of mathematics preservice teachers'. In: Northern Ghana Colleges of Education. Researchjournali's Journal of Mathematics. 2018;5(3):1-19.
42. Atteh E, Boadi A, Andam EA. Model for implementing cooperative learning in a mathematics classroom. Asian J Adv Res Rep. 2019;11(4):14-9.
43. Marton M, Saljo L. The effects of cooperative learning strategy of TGT on the attitude of year four students toward mathematics in SRK Sekaan. 2016;1:23-39.
44. Frank ND. An overview of research on cooperative learning related to mathematics. J Res Math Educ. 2017;22(5):362-5.
45. Watts M, Moore RL. Teaching introductory economics with a collaborative learning laboratory component. J Econ Educ. 2018;29(4):321-30.
46. Linchevski P, Kutscher S. Effectiveness of cooperative learning on critical thinking disposition of secondary school students. Issues and ideas. Educ. 2018:41-62.
47. Karali Y, Aydemir H. The effect of cooperative learning on the academic achievement and attitude of students in Mathematics class. Acad J. 2018;13(21):712-22.
48. Denbe GD. Cooperative learning instructional approach for students' mathematics achievement and attitude towards mathematics: a case study on probability and statistics lesson at a governmental secondary school in Ethiopia. J Educ Manag Stud. 2018;8(3):1-12.
49. Olanrewaju KM. Effects of collaborative learning technique and mathematics anxiety on mathematics learning achievement among secondary school students in Gombe State, Nigeria. J Educ Manag Stud. 2019;2(2):3-13.
50. Effandi Z. Cooperative learning for science teaching. Kuala Lumpur: Kebangsaan University Press; 2003.
51. Carbonneau KJ, Wong RM, Borysenko N. The influence of perceptually rich

manipulatives and collaboration on mathematic problem-solving and perseverance. Contemp Educ Psychol. 2020;61:1-11.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/91640