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The Effect of Cooperative Problem-Solving Method on Students' Motivation Towards Learning Algebra

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ABSTRACT

This study aimed to examine the effect of cooperative problem-solving method on grade nine secondary school students' motivation towards learning algebra. In this study, pretest-posttest non-equivalent group quasi-experimental design was employed. The data were collected from 142 grade ninth students using mathematics motivation questionnaire and analyzed using paired sample t-test, analysis of variance, and analysis of covariance. The result revealed that there was a statistically significant mean difference between groups on intrinsic goal orientation, extrinsic goal orientation, task-value, control of beliefs for learning, self-efficacy, and total motivation of students to learn algebra. Besides, except test anxiety motivation component, students' motivation and its components to learn algebra were affected by the cooperative problem-solving and the problem-solving methods. However, there was no statistically significant mean difference between groups on test anxiety motivation component. Finally, we recommend that further study is needed to examine how students test anxiety can be improved.

Keywords: algebra, cooperative problem-solving, motivation, problem-solving

INTRODUCTION

Internationally, there are two central topics in secondary mathematics education, algebra and geometry. Particularly, success in algebra is required in the twenty-first century (Ketterlin-Geller & Chard, 2011). However, students have difficulty in algebra and solving algebra problems when compare to other mathematical topics and problems (Ajai et al., 2013; Jäder et al., 2019; Jupri & Drijvers, 2016). Regrettably, these difficulties with algebra lead students to low motivation and achievement (Barbieri et al., 2019). Understanding these difficulties with algebra and finding methods to improve students' success in learning algebra is crucial. This showed that we should change our teaching and learning practice and give emphasis to a student-centered approach. Therefore, it is important to practice and promote effective teaching methods like integrating cooperative learning strategies and problem-solving method to enhance students' interest and motivation towards mathematics (Ahmed et al., 2020). According to Berihulay (2012) and Daniel (2004), practically in Ethiopia problem-solving method did not give attention to use as an active learning strategy and was poorly implemented particularly in Addis Ababa secondary schools.

As Razak (2016) defined think pair share (TPS) cooperative learning strategy is a motivating learning strategy that encourages students to work individually, in a small group, and as a whole class at the same time. Napitupulu and Surya (2019) described TPS as a cooperative learning model that provokes student motivation towards mathematics activities and make students more energetic and socialize, boost collaboration among students in the classroom as well as other activities. Therefore, the cooperative problem-solving method is a teaching method that gives more time for students to understand algebra concepts and solve algebra problems individually and in small cooperative groups. According to Irhamna et al. (2020), students' motivation to learn mathematics (algebra) plays a vital role by increasing their interest and enthusiasm to learn concepts and solve problems individually and as a small cooperative group. Moreover, motivation has a great impact on students learning outcomes. This means that if students have good motivation to learn mathematics, then they will achieve better in mathematics.

Many factors can affect students' achievement and motivation in mathematics. These factors can be categorized as external and internal factors. According to Muzamil et al. (2019), all social and non-social factors that affect students' achievement are external factors. Whereas, self-efficacy, task value, and other inner factors that affect student achievement and motivation are known as internal factors. Self-efficacy is a way of student's self-assessment of his/her performance is judged based on correct or incorrect, capability or incapability, good or bad in working or performing what is needed. It means that if students have confidence, commitment, and capability to do or solve problems, then we can say that they have high self-efficacy.

Beside self-efficacy, the thing that regulates students' accomplishment rate to solve the problem or to complete the task is task value. Students' effort, persistency, and choice to solve the problems is related to task value. Similar to self-efficacy, a student who has high task value will exert his/her maximum effort that he/she has to solve the problem or to accomplish the task. In line with this, in a study, Muzamil et al. (2019) sought to assess the effectiveness of the group-guided problem-solving method to develop students' self-efficacy and task value. Pre-test post-test control group design was employed. In order to answer the research questions, the data were collected from 20 high school students using questionnaire and analyzed by MANOVA. The results displayed that students' self-efficacy and task value were affected by group-guided problem-solving method. Consequently, the finding demonstrated that the application of group guided problem-solving method is effective to develop the task value and self-efficacy of the students.

In Ethiopia, particularly the quality of mathematics education at all levels is a serious problem for the Ministry of Education (NLA, 2010). Some of the key factors are the following; the lack of interrelated content, pedagogy (like; widely use of the traditional (lecture) method), low problem-solving skill, low motivation, and negative attitude towards mathematics (Assefa et al., 2021; NLA, 2014). For instance, the report of national learning assessment (NLA, 2014) showed that in grade 10th the mean score for mathematics was 34.7 which was very low and far from the expected mean score of 50. Correspondingly, the report of the annual abstract of Addis Ababa Education Bureau (2018) showed that due to students' low motivation to learn mathematics and other factors secondary school students' were performing low in mathematics. To address some of these problems, this study was conducted by applying the cooperative problem-solving method in learning algebra, and assessed the impact of the method on students' motivation towards algebra. The objective of the study was to examine the effect of cooperative problem-solving method on grade nine secondary school students' motivation in learning algebra. Besides, the guiding research question were:

1. Is there a significant pretest mean difference in motivation and its components between the two interventions (problem-solving and cooperative problem-solving) and comparison groups in learning algebra?
2. Is there a significant mean difference between pretest and posttest in motivation and its components within the two interventions (problem-solving and cooperative problem-solving) and comparison groups in learning algebra?
3. Is there a significant posttest mean difference in motivation and its components between the two interventions (problem-solving and cooperative problem-solving) and comparison groups in learning algebra?

The main significance of the study was to give a direction for mathematics teachers on how to develop students' motivation towards learning mathematics (algebra) by using different approaches such as the integration of think-pair-share cooperative learning strategy and problem-solving method for teaching and learning mathematics in general and algebra in particular. The other significance of this study was for policy makers and textbook writers for considering and recommending for teachers such types of active learning methods to improve students' motivation towards learning algebra. Also, this study was significant for researchers to use it as a source and provide a direction for conducting related studies in mathematics or other subjects.

Contribution of This Study to the Literature

Across the globe, in all countries, there is a need for producing problem-solver citizens to overcome individual, national as well as international problems. Moreover, there is a need to use student-centered (like problem-solving and cooperative learning methods) methods for developing students' achievement and motivation, to learn hard science subjects (like; mathematics) and to solve real-life or practical problems. There is a need to assess different ways for improving students' motivation towards mathematics and interest to solve different problems. Generally, there is a need to have students' 21st century skills. Thus, this study will have a contribution to these needs. Moreover, researchers may use the findings of this study as input for their studies.

Theoretical Framework

This study's theoretical foundation is based on social constructivism theory. Individuals generate meaning and increase understanding for themselves through interacting in a social setting. According to social constructivism a teaching and learning approach, everything is learnt twice; first socially, then individually; all knowledge is socially constructed; all learning is group learning; and thought and speech are the keys to human awareness are some of the basic principles of social constructivism (Burr, 2015; Vygotsky, 1978). Cooperative learning is a fundamental theme in Vygotsky's (1978) work because students may achieve a better degree of motivation, knowledge, and problem-solving skill via interactions with teachers and classmates than they might on their own (Vygotsky, 1978). This higher level is called "zone of proximal development (ZPD)" and simply defined as, the gap between the current developmental level as per determine by self-govern and the level of potential enhanced under teacher guidance or in cooperation with peers. We believe that teaching students using problem-solving combined with cooperative learning methods will improve their motivation to learn mathematics by involving them in mathematical problems individually and in small interactive cooperative groups.

METHODOLOGY

Design

A pretest-posttest non-equivalent group design was used in this study. It is one of the most used designs in educational research, and it entails giving a pretest and a posttest to both an experimental and a control group, but the groups do not share pre-experimental sampling equivalency. This design was more appropriate for this study than other designs because it conducted on the natural setting of school and classrooms, groups were non-randomly assigned as control and treatment, it includes students' behavior and practice, used pretest and posttest data, and it was difficult to control all variables.

Participants

This study was conducted in Addis Ababa city administration, Ethiopia. Addis Ababa city is the largest and the capital city of Ethiopia. The population of this study was all grade nine students in governmental secondary schools in Addis Ababa. There are eleven sub-cities in Addis Ababa city administration. Among these sub-cities, three sub-cities and three governmental secondary schools (one school from one sub-city) were chosen using a simple random sampling lottery method. From these secondary schools, three grade nine intact class with a total number of 142 students were selected using simple random sampling technique for forming treatment and comparison groups. All participants were informed about the objective of the study and they were voluntary and their parents have signed on the consent letter to let them participate in this study. 78 (54.93%) of them were females and 64 (45.07%) of them were males. When we see participants' age, 64 (45.07%) of them were between the age of 14 and 15, 69 (48.59%) of them were between 16 and 17, and the remaining 9 (6.34%) of them were 18 and above years old. Moreover, 47 (18 males, and 29 female) in the comparison group, 47 (27 males, and 20 female) in treatment group one, and 48 (19 males, and 29 female) in treatment group two students were found.

Data Collection Instrument

The mathematics motivation questionnaire (MMQ) was adapted from Liu and Lin (2010) and used to evaluate students' motivation in learning algebra using the cooperative problem-solving, problem-solving, and traditional lecture methods. The reason we used their instrument, it was developed for measuring secondary school students' motivation towards mathematics which was appropriate to our study. Each item has 5 rating scales such as strongly disagree (1), disagree (2), undecided (3), agree (4), and strongly agree (5). During scoring, negatively stated items were reversely scored, 1 for 'strongly agree', 2 for 'agree', 3 for 'undecided', 4 for 'disagree', and 5 for 'strongly disagree'.

According to literatures the motivation has six sub-components; intrinsic goal orientation, extrinsic goal orientation, task value, control beliefs for learning, self-efficacy, and test anxiety (Camara, 2013; Liu & Lin, 2010; Pintrich, 1991). Student's innate motives why he/she was involved in learning algebra is the intrinsic goal that includes mastery of the task, curiosity, and personal challenge (items: 1, 2, 13, and 14) and items like; "I'm very satisfied if I understand the topics and problems in this class." The extrinsic goal referred to the perception of a student for the external reasons why he or she was involved in learning algebra. Some reasons could be rewards, grades, evaluations by others, performance, or competition (items: 3, 4, 15, and 16) like, "I hope I can get higher result in this algebra class than any other classmates." The control of learning behavior referred to the perception of the student about expected outcome of learning algebra (items: 7, 8, 19, and 20**)** like, "When I face a problem in this algebra class my teacher and classmates are there to help me." The self-efficacy component referred to student's opinion that learning the topics or solve the problem would lead to success (items: 9, 10, 21, and 22) like, "I expect to do well in algebra class." The task value component referred to the student's view of how stimulating, important, and useful the algebra was to him or her (items: 5, 6, 17, and 18) like, "I feel the topics and activities/problems in algebra are useful." The test anxiety component referred to the student's view of any worry while learning algebra and solving algebra problems or while taking exams or tests (items: 11, 12, 23, and 24) like, "when I take a problem/activity I think about I can't do it."

In this study, the widely used types of validity, construct, face and content validity were employed by the researchers to check the validity of instrument. The face and content validity of the instrument was evaluated using experts from different departments like mathematics, language, and psychology. Thus, the instruments were revised according to the feedback obtained. The construct validity of the instrument is reinforced by the fact that it has been used by other researchers and has been tested and confirmed. Factor analysis and correlational analysis were used to confirm that construct validity was satisfied. Moreover, before the instrument was administrated to collect the actual data, it was piloted at Menelik II secondary school of Addis Ababa city administration. The reliability of the motivation questionnaire was assessed by SPSS version 24 using coefficient omega and it was 0. 881. The value of the instrument was within acceptable range. Therefore, the instrument was considered as reliable and valid to apply in the study. After the revision was made to the piloted instrument, the actual data was collected before and after the interventions were implemented. Finally, the collected data was analyzed using mean, standard deviation, paired sample t-test, analysis of variance (ANOVA), and analysis of covariate (ANCOVA).

Procedure

Following the piloting and amendment of the instrument, for two weeks, the two volunteer mathematics teachers who taught the intervention groups received training on the study's objective, treatment methods and problem-solving model, how to prepare lesson plans, and how to implement the intervention in their own classroom. In addition, the teacher assigned for cooperative problem-solving group (CPSG) got training on cooperative learning (particularly the TPS strategy) whereas the teacher assigned for comparison group did not get any training and he taught his students as he taught regularly (traditional lecture method). The problem-solving group (PSG) students were taught algebra (solution of equations) topics using the problem-solving approach during the intervention period. The teaching process began by asking students and revising some key concepts in solution of equations (linear equations, system of linear equations, absolute value equations, and quadratic equations) and then showing them how to solve problems using these concepts and a problem-solving model. The teacher then provides real-life problems as a class activity and encourages students to solve problems on their own. Finally, the teacher will motivate, facilitate, and involve students in solving the problem at hand, as well as provide feedback on their work and summarize basic concepts of the topics and their applications in solving problems.

The cooperative problem-solving approach (i.e. the combination of problem-solving and the think-pair-share cooperative learning strategy) was employed in the cooperative problem-solving group (CPSG). The teaching process began with students being asked to recall and revise some key concepts in equation solution (linear equations, systems of linear equations, absolute

Table 1. One-way analysis of variance summary of groups on motivation & its components pre-test in learning mathematics

Variable		SS	df	MS	F	p	η^2
Extrinsic goal orientation pre-test	Between groups	5.493	2	2.746	6.892	.001	.0902
	Within groups	55.394	139	.399			
	Total	60.886	141				
Intrinsic goal orientation pre-test	Between groups	.491	2	.246	.695	.501	.0090
	Within groups	49.148	139	.354			
	Total	49.639	141				
Task value pre-test	Between groups	2.581	2	1.291	2.508	.085	.0348
	Within groups	71.534	139	.515			
	Total	74.116	141				
Control of learning behavior pre-test	Between groups	7.108	2	3.554	5.889	.004	.0781
	Within groups	83.883	139	.603			
	Total	90.990	141				
Self-efficacy pre-test	Between groups	3.102	2	1.551	2.101	.126	.0293
	Within groups	102.617	139	.738			
	Total	105.720	141				
Test anxiety pre-test	Between groups	3.698	2	1.849	5.806	.054	.0370
	Within groups	44.266	139	.318			
	Total	47.964	141				
Motivation pre-test	Between groups	1.856	2	.928	3.613	.030	0.05
	Within groups	35.715	139	.257			
	Total	37.572	141				

Note. *The mean difference is significant at the 0.05 level

value equations, and quadratic equations), followed by showing them how to solve problems using these concepts and a problem-solving model. The teacher then provides real-life problems to the students as a class activity and encourages them to solve them independently for a few minutes. Students were given time to think about and try the problems on their own before being divided into small groups (pairs) to discuss their findings. The teacher encourages, guides, and supports students in discussing and solving problems together, and appoints any member of the group to present and share their answers with the entire class, as well as assisting the entire class in commenting and adding points. Finally, the teacher gives comments on their work and summarizes the basic concepts of the topics as well as how they apply for solving problems. In the comparison group (CG), however, the traditional lecture method was used. The research took place over the course of eight weeks. The content was prepared in line with the curriculum and the same content was taught in each of the three groups. When the study period is completed, the MMQ was administered as a post-test in order to compare the findings from the comparison group and the two intervention groups.

RESULTS

Based on the purpose of this study examining the effect of the cooperative problem-solving method on grade nine secondary school students' motivation in learning algebra, and to address the research questions of this study we used different statistical tests and the results were analyzed, interpreted and discussed, as follows:

Research question 1: *Is there a significant pretest mean difference in motivation and its components between the two interventions (problem-solving and cooperative problem-solving) and comparison groups in learning algebra?*

The descriptive statistics result of all components of motivation showed that there was a mean increase from pretest to posttest within each group. Moreover, the result showed that there was a pretest mean difference on motivation and its components between groups to learn algebra. To see the statistical significance pretest mean difference between groups or to answer the above research question 1, one-way analysis of variance (ANOVA) was employed and its assumptions were checked and presented, as follows: Assumptions of ANOVA are; observations are independent (the value of one observation is not related to any other observation), the dependent variable is normally distributed for each group, and variances on the dependent variable are equal across groups. When we see the first assumption, all the three pretest observations are independent of each other. The value of observation one is obtained from problem-solving group, the value of the second observation obtained from cooperative problem-solving group, and the last third, observation was obtained from the comparison group. Therefore, this assumption is not violated. The second assumption normality, it was checked by skewness, kurtosis, and Z value. The result of skewness and kurtosis are between -1 and 1, and the Z value of skewness and kurtosis are between 1.96 (n=142) then the data is normally distributed. Therefore, we can conclude that students' motivation pretest data was normally distributed (Mishra et al., 2019). The homogeneity of variance was checked by Levene's test and Levene's test result of pretest was not significant (p>.05).

Table 1 showed the result of one-way analysis of variance (ANOVA) summary of all three groups on motivation and components of motivation pretest in learning algebra. The result showed that there were a statistically significant mean different between the groups on extrinsic goal orientation [$F(2, 139)=6.892$, $p=.001$, and $\eta^2=.0902$], and control of learning behavior [$F(2,139)=5.889$, $p=.004$, and $\eta^2=.0781$) components of motivation pretest with medium effect sizes. However, there were no statistically significant pretest mean different between the groups on intrinsic goal orientation [$F(2, 139)=.695$, $p=.501$, and $\eta^2=.0090$], task value [$F(2, 139)=2.508$, $p=.085$, and $\eta^2=.0348$], self-efficacy [$F(2, 139)=2.101$, $p=.126$, and $\eta^2=.0293$], and test anxiety [$F(2,139)=5.806$, $p=.054$, and $\eta^2=.0370$] components of motivation.

Table 2. Paired samples t-test on pre-test & post-test of students' total motivation & its components in learning algebra by groups

Variable	Group	Paired differences		t	df	p	d
		M	SD				
Intrinsic goal orientation: Pre-test/post-test	Comparison group	-.03617	.3521	-.704	46	.485	.10
	Problem-solving	-.43723	.8602	-3.485	46	.001	.51
	Cooperative problem-solving	-.74792	.8816	-5.878	47	.000	.80
Extrinsic goal orientation: Pre-test/post-test	Comparison group	-.07	.40	-1.253	46	.217	.18
	Problem-solving	-.51	.84	-4.150	46	.000	.61
	Cooperative problem-solving	-1.17	.73	-11.07	47	.000	1.6
Task value: Pre-test/post-test	Comparison group	-.06809	.59522	-.784	46	.437	.11
	Problem-solving	-.43936	.99558	-3.025	46	.004	.44
	Cooperative problem-solving	-.69042	.97592	-8.764	47	.000	.71
Control beliefs for learning: Pre-test/post-test	Comparison group	.01702	.61858	.189	46	.851	.03
	Problem-solving	-.47128	.91875	-3.517	46	.001	0.51
	Cooperative problem-solving	-1.0188	1.8116	-8.696	47	.000	.61
Self-efficacy: Pre-test/post-test	Comparison group	-.00106	.77876	-.009	46	.993	0.0
	Problem-solving	-.61277	.89549	-4.691	46	.000	.68
	Cooperative problem-solving	-.81563	.76854	-7.353	47	.000	1.06
Test anxiety: Pre-test/post-test	Comparison group	.04894	.62009	.541	46	.591	.07
	Problem-solving	-.07660	.90017	-.583	46	.563	.08
	Cooperative problem-solving	.21979	.91917	1.657	47	.104	.23
Motivation: Pre-test/post-test	Comparison group	-.04362	.45785	-.653	46	.517	.09
	Problem-solving	-.44848	.58074	-5.294	46	.000	.77
	Cooperative problem-solving	-.78988	.55653	-9.833	47	.000	1.4

Note. M: Total motivation

Moreover, the result of the total motivation pretest showed that there was a statistically significant mean difference between groups, F(2, 139)=3.613, p=.030. The effect size of the total motivation pretest is η^2=.05 and according to Cohen's (1988) guidelines, it is a small effect. In order to identify the significant mean difference between groups on total motivation and components of motivation, multiple comparisons of post hoc (Tukey HSD) test was employed. The result revealed that the significant mean difference of extrinsic goal orientation, control of learning behavior, and total motivation pretest was obtained between only the comparison group and the cooperative problem-solving group. Moreover, all the results showed that there was a mean difference between groups on their pretest and posttests of motivation components and total motivation. Then to check whether there was a significant difference in the mean of pretest and posttest of students' motivation and its components in learning algebra within each of the two interventions (problem-solving and cooperative problem-solving) and comparison groups (or to answer research question 2) we conducted paired sample t-test.

Assumptions of paired sample t-test are; the independent variable is dichotomous–from each group we obtained pre-test and post-test data independently. The variables were normally. Another assumption was that there should not be outliers in the data. Outliers of all data were checked using a box plot and there were no outliers in the data. Accordingly, this assumption was not violated. Since all assumptions were not violated we run paired sample t-test and the result is presented in **Table 2**.

Table 2 presented the paired sample t-test of pretest and posttest mean difference results of total motivation and motivation components in each group. Except the test anxiety motivation component, all the intrinsic goal orientation, extrinsic goal orientation, task value, control beliefs for learning, and self-efficacy results showed that there was no significant means difference between the pretest and the posttest in comparison group students' to learn algebra, t(46)=-.704, p=.485, d=.10, t(46)=-1.253, p=.217, d=.18, t(46)=-.784, p=.437, d=.11, t(46)=.189, p=.851, and d=.03, and t(46)=-.009, p=.993, respectively. Whereas, there were a significant means difference between the pretest and the posttest on intrinsic, extrinsic, task value, control beliefs for learning, and self-efficacy motivation components in problem-solving group students to learn algebra, t(46)=-3.485, p=.001, d=.51, t(46)=-4.150, p=.000, d=.61, t(46)=-3.025, p=.004, d=.44, t(46)=-3.517, p=.001, and d=.51 and t(46)=-4.691, p=.000 d=.68, respectively. Except task value, the effect size of all motivation components were medium according to Cohen's (1988) guidelines. However, the effect size of task value motivation component was small.

Furthermore, for cooperative problem-solving group students', there were significant means difference between pretest and posttest results on intrinsic goal orientation, extrinsic goal orientation, task value, control beliefs for learning, and self-efficacy motivation components to learn algebra, t(47)=-5.878, p=.000, d=.8, t(47)=-11.077, p=.000, d=1.6, t(47)=8.764, p=.000, d=.71, t(47)=-8.696, p=.000, d=.61, and t(47)=-7.353, p=.000 d=1.06, respectively. This indicated that the size of the mean differences was medium and large according to Cohen's (1988) guideline, respectively. However, for test anxiety motivation component, the results revealed that there were no significant mean difference between the pretest and the posttest for the comparison group, problem-solving group, and cooperative problem-solving group, t(46)=.541, p=.591, d=.07, t(46)=-.583, p=.563, d=.08, and t(47)=1.657, p=.104, d=.23, respectively. Finally, the result of total motivation for each group portrayed that there was no significant mean difference between pretest and posttest of comparison group students' motivation to learn algebra, t(46)=-.653, p=.517, and d=.09. This meant that students' motivation to learn algebra was not affected by the traditional teaching method. However, there were a significant mean difference between pretest and posttest motivation in problem-solving group and cooperative problem-solving group students, t(46)=-5.294, p=.000, d=.77 and t(47)=-9.833, p=.000, d=1.4, respectively. The effect size of the problem-solving group and the cooperative problem-solving group were .77 and 1.4 which were medium and large effects by Cohen's (1988) guidelines respectively. This showed that the overall students' motivation was affected by the treatments.

Table 3. Adjusted & unadjusted means & variability on the three groups for students' motivation & its components in learning algebra using pre-tests as a covariate

Variable	Groups	N	Unadjusted		Adjusted	
			M	SD	M	SE
Intrinsic goal orientation	Comparison group	47	3.1383	.55121	3.204	.081
	Problem-solving	47	3.6330	.52090	3.585	.079
	Cooperative problem-solving	48	3.8021	.55294	3.787	.080
Extrinsic goal orientation	Comparison group	47	3.5585	.39773	3.550	.067
	Problem-solving	47	3.7500	.53416	3.740	.069
	Cooperative problem-solving	48	4.1719	.54859	4.240	.073
Task value	Comparison group	47	3.5213	.56825	3.465	.079
	Problem-solving	47	3.8351	.63262	3.839	.078
	Cooperative problem-solving	48	4.1042	.46078	4.146	.079
Control beliefs for learning	Comparison group	47	3.6383	.66718	3.474	.084
	Problem-solving	47	3.7713	.59853	3.775	.078
	Cooperative problem-solving	48	4.1354	.50254	4.177	.081
Self-efficacy	Comparison group	47	3.6117	.86729	3.491	.081
	Problem-solving	47	3.8936	.54858	3.903	.080
	Cooperative problem-solving	48	4.1302	.39272	4.146	.079
Test anxiety	Comparison group	47	3.5851	.48700	3.559	.088
	Problem-solving	47	3.3830	.59630	3.378	.092
	Cooperative problem-solving	48	3.4427	.70379	3.486	.089
Motivation	Comparison group	47	3.5160	.38594	3.462	.054
	Problem-solving	47	3.7166	.36211	3.719	.051
	Cooperative problem-solving	48	3.9940	.33245	4.018	.051

Since the pretest result of extrinsic goal orientation, control beliefs for learning, and total motivation were significant (see **Table 1**) we used analysis of covariance (ANCOVA) to analyze the posttest results and presented and interpreted, as follows: **Table 3** displayed the result of the adjusted and unadjusted means of motivation and its components posttest of each group. The result of the extrinsic goal orientation motivation component revealed that there was a difference between the adjusted and unadjusted posttest mean scores across all groups using pretest of extrinsic goal orientation as a covariate. The result exposed that the cooperative problem-solving group students had a higher mean than others groups before and after controlling the effect of its pretest, M=4.17 and adjusted mean Ma=4.24, respectively. The mean scores of the comparison group are M=3.5585 and Ma=3.550 and showing the smallest posttest mean scores than others groups before and after controlling the effect of its pretest. Moreover, a similar result was observed for the intrinsic goal orientation component.

In **Table 3**, the result of row four presented that there was a difference between the adjusted and unadjusted posttest mean scores across all groups using pretest of control beliefs for learning as a covariate. The result revealed that the cooperative problem-solving group students had a higher mean than other groups before and after controlling the effect of its pretest, M=4.1354 and adjusted mean Ma=4.177, respectively. The mean scores of the comparison group were M=3.6383 and Ma=3.474 and showed the smallest posttest mean scores than other groups before and after controlling the effect of control beliefs for learning pretest on motivation component. Furthermore, for task value and self-efficacy components, similar results were portrayed as control of beliefs for learning before and after controlling the effect of their pretests.

The result of the test anxiety component presented that there was a difference between the adjusted and unadjusted posttest mean scores across all groups using pretest of test anxiety as a covariate. The result revealed that comparison group students had a higher mean than others groups before and after controlling the effect of its pretest, M=3.5851 and adjusted mean Ma=3.559, respectively. The mean scores of the problem-solving group were M=3.3830 and Ma=3.378 and showed the smallest posttest mean scores than other groups before and after controlling the effect of its pretest on learning algebra.

The result in the last row of **Table 3** presented that there was a difference between unadjusted and adjusted mean within each group before and after controlling the total motivation pretest. The result uncovered that cooperative problem-solving group students had higher motivation mean scores than other groups before and after controlling the effect of its pretest, M=3.99 and adjusted mean Ma=4.018, respectively. The mean scores of the comparison group are M=3.516 and Ma=3.462 and showing the smallest posttest mean scores than others groups before and after controlling the effect of its pretest.

Assumptions of analysis of covariance are; observations are independent (the value of one observation is not related to any other observation), normally of the data, linearity, and homogeneity of variance. When we see the first assumption, all three motivation pretest observations are independent of each other. The value of observation one is obtained from the problem-solving group, the value of the second observation is obtained from the cooperative problem-solving group, and the last observation was obtained from the comparison group. Therefore, this assumption is not violated. The second assumption normality was checked by skewness, kurtosis, and Z value. The result of skewness and kurtosis are between -1 and 1, and the Z value of skewness and kurtosis are between ±1.96(n=142) then the posttest data is normally distributed. Therefore, we can conclude that the posttest data were normally distributed (Mishra et al., 2019). The linearity assumption was checked by a scatter plot and the result showed that there was a linear relationship between the pretest and the posttest results. The homogeneity of variance was checked by Levene's test and Levene's test result of the posttest was not significant (p>.05).

Table 4. Analysis of covariance for students' motivation & its components in learning algebra as a function of the three groups, pre-tests as a covariate

Variable	Source	Type III sum of squares	df	Ms	F	p	η^2
Intrinsic goal orientation	Pre-test	.695	1	.695	2.242	.137	.016
	Groups	9.329	2	3.110	10.035	.000	.179
	Error	42.760	139	.310			
Extrinsic goal orientation	Pre-test	3.069	1	.256	1.228	.273	.116
	Groups	9.375	2	4.688	18.861	.000	.213
	Error	34.546	139	.249			
Task value	Pre-test	2.879	1	2.879	10.226	.002	.070
	Groups	3.486	2	1.743	6.190	.003	.083
	Error	38.292	136	.282			
Control beliefs for learning	Pre-test	5.778	1	5.778	20.102	.000	.129
	Groups	16.041	2	3.208	11.162	.000	.291
	Error	39.091	139	.287			
Self-efficacy	Pre-test	7.625	1	7.625	25.900	.000	.160
	Groups	8.220	2	4.110	13.961	.000	.170
	Error	40.038	139	.294			
Test anxiety	Pre-test	.043	1	.043	.121	.729	.001
	Groups	1.848	2	.924	2.598	.078	.037
	Error	48.372	139	.356			
Motivation	Pre-test	1.336	1	1.336	11.176	.001	.076
	Groups	7.301	2	1.460	12.215	.000	.310
	Error	16.258	139	.120			

Note. *The mean difference is significant at the 0.05 level

Research question 2: *Is there a significant posttest mean difference in motivation and its components between the two interventions (Problem-solving and cooperative problem-solving) and comparison groups in learning algebra?*

To answer this research question or to know the difference between groups in the above table observed were significant or not, the result of the analysis of covariance was presented and interpreted hereunder.

Table 4 presented the results of analysis of covariance (ANCOVA) for students' motivation and its components in learning algebra as a function of the three groups. for the intrinsic and extrinsic goal orientations, the results showed that there was a significant mean difference between groups on students' posttest of intrinsic and extrinsic goal orientations after controlling the effect of pre-tests of intrinsic and extrinsic goal orientations, $F(2, 139)=10.035$, $p=.000$, and $\eta^2=.179$, and $F(2, 139)=18.861$, $p=.000$, and $\eta^2=.213$. The effect sizes of intrinsic and extrinsic goal orientations were .179 and .213 which were large effects with Cohen's (1988) guidelines.

In **Table 4**, the result depicted that there was a significant mean difference between groups on task value motivation component after controlling its pretest, $F(2, 139)=6.190$, $p=.003$, and $\eta^2=.083$. The partial eta squared is .083 which is a medium effect according to Cohen's (1988) guidelines. The result in row four showed that there was a statistically significant difference between groups on the posttest of control of beliefs for learning algebra after controlling its pretest, $F(2, 139)=11.162$, $p=.000$. The effect size of control of beliefs for learning after controlling the pretest as a covariate was $\eta^2=.291$ which was a large effect according to Cohen's (1988) guidelines.

The result of the fifth row on **Table 4** revealed that there was a significant mean difference between groups on students' self-efficacy posttest after controlling its pretest, $F(2, 139)=13.961$, $p=.000$, $\eta^2=.17$. The effect size was $\eta^2=.17$, which was a large effect according to Cohen's (1988) guidelines. Moreover, the result of the test anxiety motivation component depicted that there was no significant mean difference between groups, $F(2, 139)=2.598$, and $p=.078$. Thus, students' test anxiety was not affected by any of the treatments.

On the last row of **Table 4**, the result showed that there was a statistically significant mean difference between groups on total motivation posttest after controlling the pretest, $F(2, 139)=12.215$, $p=.000$. The effect size after controlling the total motivation pretest as a covariate was $\eta^2=.310$, which was a large effect according to Cohen (1988) guidelines. Since the analysis of covariance was significant for motivation and its components posttest, post hoc analysis was conducted using the Bonferroni test to identify which group was significantly different from the other.

The result portrayed that there was a significant mean difference between the comparison group and problem-solving group, and the comparison group and cooperative problem-solving group on the posttest of intrinsic goal orientation; on extrinsic goal orientation and control of beliefs for learning components obtained between the comparison group and the cooperative problem-solving group, and the problem-solving group and the cooperative problem-solving group was observed. For the task value, the result exhibited that there was a significant mean difference between the comparison group and the problem-solving group, and the comparison group and the cooperative problem-solving group, and a significant mean difference between the comparison group and the cooperative problem-solving group was observed on students' self-efficacy to learn algebra.

Generally, for total motivation posttest, the result revealed that there was a significant mean difference between the comparison group and problem-solving group, comparison group and cooperative problem-solving group, and problem-solving group and cooperative problem-solving group.

DISCUSSION

The results showed that there was a statistically significant pretest difference between the groups on extrinsic goal orientation, control of belief for learning, and total motivation. Therefore, before the interventions have been implemented the groups were not equivalent on extrinsic goal orientation, control of belief for learning, and total motivation. A significant pretest difference was observed between only the comparison group and the cooperative problem-solving group. The effect size of the total motivation pretest is η^2=.05 and it is a minor effect according to Cohen's (1988) guidelines. However, there was no statistically significant pretest difference between the groups on intrinsic goal orientation, task value, self-efficacy, and test anxiety components of motivation. Therefore, before the intervention have been implemented the groups were equivalent on intrinsic goal orientation, task value, self-efficacy, and test anxiety components of motivation.

The result uncovered that the traditional lecture method did not bring any change to students' intrinsic goal orientation and extrinsic goal orientation motivation components for learning algebra in the comparison group. However, both the problem-solving and the cooperative problem-solving methods reasonably affect students' intrinsic goal orientation and extrinsic goal orientation motivation components to learn algebra. The cooperative problem-solving method largely affect the students' extrinsic goal orientation when compared to the other methods. These results are similar to Liang et al.'s (2018) findings on intrinsic and extrinsic motivation. The result uncovered that students' intrinsic and extrinsic motivation to learn mathematics were affected by problem-solving and cooperative problem-solving (crowdsourcing contest) methods. Moreover, the finding of Shih and Reynolds (2015) supplement this result. The finding showed that the use of TPS cooperative learning strategy integrated with other active learning methods can improve students' intrinsic motivation to learn.

The difference between groups' results showed that students' posttest of intrinsic and extrinsic goal orientations, task value, and control of beliefs for learning, self-efficacy, and total motivation after controlling the effect of their pretests was significant. Moreover, the results indicated that a significant mean difference between the pretest and the posttest in the problem-solving group and cooperative problem-solving group students was identified. Nevertheless, these motivation components were not affected by the use of the traditional methods for learning algebra. These motivation components were affected by both problem-solving and cooperative problem-solving methods. This result is similar to the result of a study carried out by Muzamil et al. (2019), which displayed that students' self-efficacy was significantly affected by the group-guided problem-solving method. Consequently, the finding confirmed that the application of group guided problem-solving method is effective to enhance the self-efficacy of the students. Moreover, Nugraha et al.'s (2018) study confirmed that students' self-efficacy was positively affected by the think-pair-share cooperative learning method. It is also similar to Cudney and Ezzell (2017) who state the finding of students' self-efficacy is highly affected when they work or solve problems cooperatively to show their ability to friends, or others.

However, for the last test anxiety motivation component, the results pointed out that there was no significant mean difference between the pretest and the posttest for the comparison group, problem-solving group, and cooperative problem-solving group. From this result, we can conclude that students' algebra test anxiety was not affected by the treatments (problem-solving and cooperative problem-solving) and the traditional teaching methods. Additionally, the result of test anxiety showed that there was no significant mean difference between groups. However, this result has contradicted the finding of Irhamna et al. (2020).

Finally, a significant motivation difference between groups was observed. It meant that both problem-solving and cooperative problem-solving methods brought a significant impact on students' motivation for learning algebra than the traditional method. In line with this, the results of studies conducted by Gok and Sýlay (2010), Shih and Reynolds (2015), and Putri et al. (2018) showed that students motivation to learn is highly affected by active learning (such as problem-solving and TPS problem-solving) methods.

CONCLUSION

In general, the problem-solving and cooperative problem-solving methods were significantly affected students' intrinsic goal orientation, extrinsic goal orientation, task value, control beliefs for learning, self-efficacy, and total motivation to learn algebra. However, there was no statistically significant mean difference between groups on the test anxiety motivation component. Moreover, students' test anxiety was not affected by any of the treatments (the problem-solving and cooperative problem-solving) and the traditional methods.

Recommendation

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

1. The schools or concerned bodies should provide training on active learning methods (like: problem-solving method and cooperative learning strategies) and motivation improving strategies to the teachers in order to improve their teaching capacity and motivating strategies. Also, the schools should provide different facilities and encourage teachers to apply different student-centered methods in their classrooms to improve student motivation and achievement.
2. By considering the topics, students' varied interests, and learning preferences mathematics teachers should apply different student-centered approaches (like TPS cooperative problem-solving method) for developing students' motivation and interest in mathematics.

3. Students should be exposed to different student-centered approaches (like; cooperative problem-solving and problem-solving methods) and teachers provide real-life problems as an activity and facilitate them to solve and develop their interest and achievement in mathematics particularly.
4. Finally, it is also recommended that future studies can be conducted on students' motivation towards physics, biology, chemistry, and social sciences subjects. Moreover, further study is needed to examine how students' test anxiety can be affected and improved.

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