



Effectiveness of Cooperative Learning on Math Anxiety, Academic Motivation and Academic Buoyancy in High school Students

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Abstract: The present study aimed to examine the effectiveness of cooperative learning on math anxiety, academic motivation and academic buoyancy in female high school students. The current research is a pretest-posttest follow-up semi experimental design with a control group. Participants were 30 students selected by purposive sampling and randomly assigned to experimental and control groups. Experimental group received cooperative learning intervention (math book contents) in 10 sessions in five weeks and control group was taught by using traditional method (lecture method) during this period. Data collection tools included Plake and Parker Mathematics Anxiety Rating Scale (1982), Harter Academic Motivation Scale (1981) and Hosseinchari and Dehghanizadeh Academic Buoyancy (2012). Analysis of variance with repeated measures and Bonferroni post hoc test were used to examine the hypotheses. The results indicated there is a significant difference between experimental and control group in math anxiety, motivation and academic buoyancy ($P < .01$). According to results, the cooperative learning improved motivation and academic buoyancy and reduced levels of math anxiety in experimental group. Consequently results supported the impact of cooperative learning in improving motivational outcomes and reducing the negative emotions in high school students.

Keywords: Cooperating learning, Math anxiety, Academic motivation, Academic buoyancy, High school students

Introduction

Students are considered the greatest human assets of any society, because they can move the wheels of progress and development by combining youth power, knowledge and learned skills. In all countries, a large portion of the national income is spent on education. Educational systems always seek to improve themselves, and the most important factor in the success of any educational system is the academic performance of its students ([Asarta & Schmidt, 2017](#)). Increasing academic performance means academic success, and academic success means how successful the learners have been in achieving the goals of the educational course. Since academic life is considered one of the most important periods in people's lives, especially teenagers and young people, and they face many challenges and obstacles such as high stress, poor grades, decreased motivation, etc. It is necessary to identify the factors that increase a person's ability to face these obstacles and challenges ([Ebrahimi Bakht et al., 2018](#)). A question that is frequently asked by students and teachers is why do we study mathematics? Or why is mathematics taught so much? Or why mathematics should be the concern of

every student? Or basically, what is the role of mathematics in everyday life? This is a question that has always been raised and unfortunately, a convincing answer that can be summarized in one sentence cannot be given ([Murat, 2016](#)). The results of recent research show a sharp drop in mathematics lessons in high school, and this is because the student does not understand mathematics and cannot communicate with it, so he is not interested in mathematics and teaching it, and suffers from math anxiety. Math anxiety is a mental condition that occurs when people face math content. This condition is described as worry or fear about performing math calculations. A person with math anxiety may feel panicked at the thought of working with numbers, making it harder to think ([Jameson & Fusco, 2014](#)). Math anxiety causes weakness of mental processes to perform math operations, negativity and confusion of students. Students with math anxiety avoid math class, math tests, and learning this subject ([Foley et al., 2017](#)). Math lesson is undoubtedly one of the most important lessons that students need to know and understand at all levels of education. For various reasons, including the teacher's teaching style, unsuccessful experiences, parental pressure, lack of practice, and difficulty in learning math concepts, many students become so afraid and anxious about this lesson and show resistance that sometimes they cannot even do the simplest math exercises. While today, due to the wide application of mathematics in new sciences and technology, there is a greater need to learn this science and understand its laws ([Aghajani et al., 2012](#)).

Studies show that students who suffer from math anxiety have known motivational and emotional factors that can be used as predictors of math anxiety ([Diani & Dwijanto, 2020](#)). One of these factors related to math anxiety is motivation. Motivation is the device of movement and activity in any work. Research evidence in the field of education indicates that motivation is one of the important factors in improving students' performance ([Wang et al., 2015](#)). Since motivational factors affect academic progress and the academic progress of students is related to the progress of the whole society, educational systems should increase their efforts to improve education and its related components, i.e. learner, teacher, environment and educational facilities ([Rump et al., 2017](#)). On the other hand, it can be said that academic buoyancy is an important factor that is the basis and foundation of a student's positive relationship with school and academic life that is an important part of his academic progress. In fact, students increase their academic buoyancy through cognitive growth, positive emotional and behavioral orientations towards school ([Gill et al., 2021](#)), as well as positive self-perception and the development of metacognitive processes ([Senobar et al., 2018](#)).

Anxiety in general and math anxiety in particular can increase the amount of distraction and the inflow of irrelevant thoughts into the mind, and by disrupting the mental structures and information processing practices, it can distort people's perceptions of mathematical phenomena and categories ([Suárez-Pellicioni et al., 2016](#)). Today, Iranian schools have moved away from their main mission (cultivation of thinking) and have become more centers and institutions for transferring knowledge to the memory of students and filling their minds instead of nurturing them. With the ever-increasing

growth of the amount of information and the challenges related to it, it becomes necessary to cultivate new learning methods in school curricula. Enhancing students' higher-order thinking skills, such as creativity, is a critical task for education institutions in the rapidly changing digital world. However, this goal seems optimistic; despite the expansion of technology applications and capabilities in recent decades, traditional lecture-based teaching continues to prevail ([Al-Zahrani, 2015](#)).

One of the important factors that cause problems in the mentioned variables, i.e. math anxiety, academic motivation and academic buoyancy of students, is related to teaching methods. Cooperative learning method is one of the strategies that reduce anxiety and increase students' self-awareness of their learning process ([Hajhosseini et al., 2017](#)). Since the nature of mathematical problems requires the use of different problem solving strategies, the use of cooperative learning in mathematics education is extremely important, because students can find different solutions to solve problems through discussion and consultation in groups, present and learn effective problem-solving strategies with the help of their peers and with the guidance of the teacher ([Amani Saribaglou et al., 2019](#)).

Cooperative learning is an educational approach to teaching and learning that involves groups of learners working together to solve a problem, complete a task, or produce a product. Cooperative learning is based on the principle that learning is inherently a social practice in which participants learn something by talking to each other ([Diani & Dwijanto, 2020](#)). Cooperative learning has both strong theoretical support and rigorous empirical support. From the point of view of behaviorists, trying to improve the performance of the group is one of the positive aspects of this method, and from the point of view of Bandura's social-cognitive theory, children learn better when they see what their friends are doing, and when they see success together in a group, their interest in learning increases. Also, Vygotsky explained the learning that occurs as a result of interactions with individuals that are more advanced than the first with the zone of proximal development (ZPD) concept ([Gredler, 2012](#)). In cooperative learning, students work in groups and the system of encouragement and reward is group rather than individual. The teacher's task is to promote the students' efficiency in the group format and monitor group learning opportunities. In this method, students organize their experiences through interaction and cooperation and improve their logical thinking and verbal communication skills. Paying attention to group goals, individual responsibilities and equal opportunities for learning are the distinctive features of the cooperative learning method ([Johnson et al., 2007](#)).

Various researches have shown the effectiveness of cooperative teaching method on increasing creative thinking and reading skills ([Habibi-Kaleybar, 2018](#)), increasing creativity and academic motivation ([Marashi & Khatami, 2017](#)), creative thinking and creativity in mathematics ([Lopes et al., 2019](#)), increasing self-regulation, creativity and academic motivation ([Sever & Akyol, 2022](#)), increasing creativity and motivation in language learning has been confirmed ([Marashi & Khatami, 2017](#)).

Since few researches have been done on the effect of cooperative learning on math anxiety, academic motivation and academic buoyancy, or at least the researches have not covered all the above variables together, it can be said that the combination of these variables has some novelty aspects. Therefore, the present study aims to find the answer to the question: Does cooperative learning have an effect on improving students' math anxiety, motivation, and academic buoyancy? Therefore, the present study seeks to test the following hypotheses:

First hypothesis: cooperative teaching method has a significant effect on the math anxiety in female students.

Second hypothesis: cooperative teaching method has a significant effect on academic motivation in female students.

The third hypothesis: cooperative teaching method has a significant effect on the academic buoyancy in female students.

Material and Methods

The present research is an applied study with a semi-experimental design pre-test-post-test and follow-up with the control group design that cooperative teaching method were considered as independent variable and math anxiety, academic motivation and academic buoyancy as dependent variables. The current research population was all female high school students in district 5 of Tehran (Iran) in 2020. The participants were 30 students who were selected by multi-stage cluster sampling from Tehran schools and randomly assigned to experimental and control groups (15 students in each group). The inclusion criteria include the students of each class being at the same academic level and the absence of severe physical and mental problems in them, and the exclusion criteria include the presence of severe physical and mental problems, absence of more than two sessions in the class, change of school and migration of students. The participants completed the informed consent form before the start of the study. The data were collected by the following questionnaires.

Math Anxiety Questionnaire: The Math Anxiety Questionnaire was developed in 1982 by Plick and Parker ([Sepehrianazar & Babaei, 2014](#)) in order to assess the anxiety related to participation in math and statistics classes in high school students. This version emphasizes situational anxiety, general anxiety, and test anxiety. This questionnaire has 24 statements and two sub-scales of math learning anxiety, which (the first 16 statements of the questionnaire) are related to the process of learning math and numbers, and (the last 8 statements of the questionnaire) are related to the sub-scale of math assessment anxiety, which assesses the anxiety level in the situation. The respondent must indicate his agreement or disagreement with each statement of the test in a 5-point Likert scale. This test is suitable for high school students and college students. The scoring method is 1=little anxiety, 2=low anxiety, 3=moderate anxiety, 4=almost high anxiety and 5=high anxiety. The total score of math anxiety is obtained from the sum of the scores of all expressions. Pleck and Parker administered the revised math

anxiety scale to 170 college students who had taken a math and statistics class. The average score of this scale was 84.59 with a standard deviation of 20.55. The alpha coefficient of the whole test was equal to 0.98, which indicates the good reliability of the test. Concurrent validity of the revised math anxiety scale was demonstrated through its correlation with math achievement and the original math anxiety scale. In Iran, [Leila Abdolmaleki et al. \(2013\)](#) validated this questionnaire and reported its validity at a satisfactory level and its reliability at 0.92. In the present study, the reliability of this tool was calculated using Cronbach's alpha and it was 0.87.

Academic motivation questionnaire: Harter's standard academic motivation questionnaire ([Harter & Jackson, 1992](#)) includes 33 items and its purpose is to investigate academic motivation among students. This tool is a modified form of Harter's questionnaire as a tool for measuring academic motivation. Harter's original questionnaire measures academic motivation with bipolar questions, one pole of which is internal motivation and the other pole is external motivation, and the subject's answer to each question can only include one of the external or internal reasons. The scoring of this questionnaire is based on a Likert scale (never, 1; rarely, 2; sometimes, 3; most of the time, 4; almost always, 5). This questionnaire has a total score. In Iran, the construct validity and reliability of this questionnaire has been calculated and confirmed by [Bohrani \(2009\)](#). So that the validity of the structure has shown two internal and external motivation factors and its reliability has been estimated by Cronbach's alpha method and test-retest in the internal motivation factor as 0.85 and 0.86 and the external motivation factor as 0.69 and 0.72 respectively. In the present study, the reliability of this tool was calculated using Cronbach's alpha of 0.71.

Academic Buoyancy Questionnaire: Academic Buoyancy Questionnaire was created by Hosseinchari and Dehghanizadeh (2013), based on the academic buoyancy scale of Martin and Marsh (2006). This tool has 9 items that are answered based on a five-point Likert scale from completely disagree (1 point) to completely agree (5 points). In the research of Dehghanizadeh et al. (2013), the reliability coefficient of this scale using Cronbach's alpha method was equal to 0.77 and its validity according to the correlation of each item with the total score ranged from 0.54 to 0.64. In the present study, the reliability of this scale was obtained with Cronbach's alpha method of 0.85.

Research executing method: Before starting the study and as a pre-test, research questionnaires were administered in both groups. To implement the cooperative method, the researcher provided the necessary information regarding the cooperative teaching method and the correct way to implement it to the class teacher in the experimental group. After the teacher was completely familiar with this method, in order to make the students aware and familiar with the cooperative teaching method, the class teacher along with the researcher in the form of an educational couple practically implemented the method for the students. Since this method was accompanied by asking targeted questions and step by step by the teacher and giving answers and reaching the answer to the problem by the learner, in the stage of playing the role of the teacher and the researcher, some points related to the way of asking

questions in education, how the receiver asks for help from the training partner, how to give feedback and encourage the training partner were presented to the students. The duration of each cooperative method session was 75 minutes, 45 minutes of which the teacher taught his subject and 30 minutes were devoted to the cooperative teaching method. After teaching, the class teacher determined the educational pairs and based on the interest of the students or randomly chose one of them as the teacher and the other as the learner. The roles of the students were changed regularly. So, all of them experienced both the role of teacher and learner. The pairs of students were randomly changed after one week (two sessions). The cooperative teaching method was conducted for 10 sessions based on the chapters of the math book. Then, during the post-test, research questionnaires were administered in both groups. Finally, the collected data were analyzed with SPSS-22 and using analysis of variance with repeated measures and Bonferroni's post hoc test.

Results

According to Table 1, the average scores of math anxiety, motivation and academic buoyancy of the control group in the three stages of the test are not much different; but the average of the variables in the experimental group in the pre-test stage is different from the post-test and follow-up. In order to test the significance of the observed differences, repeated measures analysis has been used, respecting its presuppositions. The measurement scale in this research is an interval, and the people of the sample group, after matching based on intervening variables, were randomly divided into two experimental and control groups. Outliers were investigated and excluded from the analysis.

Table 1. Descriptive indicators of math anxiety, motivation and academic buoyancy of the participants in the pre-test, post-test and follow-up research variables

Phase	Group		Math anxiety	Academic motivation	Academic buoyancy
Pretest	Cooperative learning	Mean	71.000	48.333	26.800
		SD	8.392	7.247	3.783
	Control	Mean	76.333	51.267	26.867
		SD	7.807	6.777	4.658
Posttest	Cooperative learning	Mean	45.933	31.533	36.400
		SD	17.136	13.341	6.916
	Control	Mean	69.600	46.267	28.200
		SD	7.356	5.637	3.167
Follow-up	Cooperative learning	Mean	45.867	30.600	37.467
		SD	17.574	11.969	5.235
	Control	Mean	70.867	48.067	28.467
		SD	6.357	5.244	4.340

The results of variance analysis with repeated measures showed that the assumption of normality based on the Kolmogorov-Smirnov test and the assumption of homogeneity of variances was

confirmed based on Levin's test ($P > 0.05$), but the assumption of homogeneity of covariance's was not confirmed and Mauchly's Test of Sphericity indicated that the assumption of sphericity had been violated, and therefore, a Greenhouse-Geisser correction was used.

The Wilks Lambda test in Table 2 shows that there is a significant difference between the level of math anxiety, motivation and academic buoyancy of students in the three stages of the experimental group ($P < 0.01$). This means that the score of the variables has been changing during the research period. Also, the interaction between test stage and group is significant ($P < 0.01$). Therefore, the use of variance analysis test with repeated measures is allowed.

Table 2. Bonferroni's post hoc test to check the differences in the variables based on the group and stage of the tests

Variable	Source	Mean difference	SD	p
Math anxiety	Pretest-posttest	15.900	2.726	.000
	Pretest-follow-up	15.300	2.835	.000
	Posttest- follow-up	-.600	1.284	1.000
Academic motivation	Pretest-posttest	10.900	2.417	.000
	Pretest-follow-up	10.467	2.297	.000
	Posttest- follow-up	-.433	.919	1.000
Academic buoyancy	Pretest-posttest	-5.467	1.310	.001
	Pretest-follow-up	-6.133	1.180	.000
	Posttest- follow-up	-.667	.885	1.000

In Table 2, the results of the Bonferroni test show that the difference in the average scores of math anxiety, motivation and academic buoyancy at the level ($P < 0.01$) between the pre-test, post-test and follow-up stages is significant; In other words, the average scores of math anxiety, motivation and academic buoyancy in the stage after the implementation of the educational program in the experimental group have had a statistically significant difference compared to before the education. Therefore, cooperative teaching has had a positive effect on reducing math anxiety and increasing students' academic motivation and academic buoyancy. Also, the difference between the average scores posttest and the follow-up of math anxiety, academic motivation and academic buoyancy is not statistically significant ($P < 0.05$) in experimental group. As a result, there was no significant difference in math anxiety, motivation and academic buoyancy of the experimental group students after 1 month, so the effect of the intervention was established.

Discussion

The results of the first hypothesis of the present study confirmed that there is a significant difference between the social anxiety in pretest, posttest and follow-up phases in the cooperative learning group. This finding is in agreement with the previous studies ([Hajhosseini et al., 2017](#); [Lopes et al., 2019](#); [Marashi & Khatami, 2017](#)). In the explanation of this finding, according to [Marashi and Khatami \(2017\)](#), it can be said that, in an environment based on participation, learning mathematical concepts is done with group cooperation, and in addition to individual practice, group mates also help the individual in learning. They give him an example and encourage him to try harder, so the students are supported by their classmates and teacher in difficult assignments and get the opportunity to try with the help of their group mates, master the subjects and in experience less anxiety in math class. In addition, according to the cooperative learning method, the learning process is more important than the result, and students are never blamed for not finding the correct answer to the final problem. Because students have the opportunity to work with each other in a group and instead of competing, they benefit from the cooperation of others, and this leads to the absence of anxiety or at least the reduction of anxiety and worry in them. In addition, in this method, students have more opportunities to learn more difficult concepts of mathematics by asking questions and asking for explanations from the group members, and in this way they gain stronger self-confidence and control their math anxiety.

Also, the results showed that the collaborative teaching method has significantly increased the students' academic motivation. These results are in line with the findings of [Marashi and Khatami \(2017\)](#). The findings of their research indicate that cooperative learning has an effect on improving the creativity and motivation in language learning. Also, our results were consistent with the research of [Hajihoseinlou et al. \(2017\)](#). Their findings showed that the cooperative learning significantly increases self-efficacy and self-concept of student's mathematics. In general, the findings of the study revealed that the cooperative learning method is effective in developing self-regulation skills and increasing students' academic motivation. In collaborative learning, the classroom becomes a community of learners who actively work together to increase their knowledge, competence, and enjoyment ([Johnson et al., 2007](#)). The effect of collaborative learning on academic motivation can also be justified by social-cognitive theory. From this perspective, social characteristics influence learning ([Ertl et al., 2006](#)). Thus, in cooperative learning, it is the action of group members that increases academic motivation in individuals by encouraging each other. In addition, when students with different characteristics work in a group for a common goal, joint effort and interaction creates more motivation in the individual than in environments based on competition and individualism. In cooperative

learning, when students work together on assignments, friendship is established between them and more motivation to learn is created. This way of learning can lead to academic progress; Therefore, as the success in learning increases, the motivation to progress also increases.

Finally, the results showed that cooperative learning has significantly increased academic buoyancy. This finding is consistent with the findings of ([Hassanalizadehroashan et al., 2022](#)).

[Hassanalizadehroashan et al. \(2022\)](#) examined the effectiveness of cooperative learning training on the academic motivation, procrastination and academic buoyancy of high school students in Babol. The results showed that education based on collaborative learning has significantly increased the buoyancy and motivation of students. Our results are in line with the findings of ([Marashi & Khatami, 2017](#)). Collaborative learning leads to improvement and strengthening of cooperation skills and respect for others' thoughts, fostering critical thinking and tolerance of opposing thoughts. When students with different characteristics work in a work group for a common goal, they develop interest and respect for each other. In this type of learning, the learner is the main source of his own transformation, and more emphasis is placed on the free choice of criteria and values to reach scientific-social truths based on a democratic activity. Fresh, dynamic and active students have hope for life and work hard to achieve their goals. On the other hand, academic buoyancy makes students find beliefs that lead to personal ability and have positive evaluations of the school and its environment, and as a result, they will expect positive results. This makes them stronger against adverse conditions. [Hassanalizadehroashan et al. \(2022\)](#) state that academic buoyancy is a simple and useful way to understand and conceptualize students' well-being in the academic context. Academic buoyancy in its correct form causes academic progress and increases creative self-efficacy, pushes students forward, because students with positive academic emotions after understanding the problem overcome it and focus on the solution. Therefore, an optimistic and positive attitude will naturally be associated with success

An important limitation of the current research is the study was carried out during the outbreak of the Corona virus. This caused the practical part of the work to be done virtually. Another limitation of the research is the use of self-report questionnaires to collect data. The fact that the study is limited to a sample of female high school students can limit the generalizability of the findings. Based on this, it is suggested to repeat the research on male students and students of other educational levels in future studies. According to the obtained results, it is suggested to provide suitable facilities and physical equipment in schools for the implementation of cooperative learning method, including portable tables and chairs. Also, teachers are suggested to provide suitable conditions for the growth and promotion of motivational beliefs by using the cooperative learning model and give students more opportunities to

learn. Considering that most of the teachers are not familiar with the new teaching methods, it is possible to improve the quality of mathematical learning and the motivation and academic buoyancy of students by holding training courses for teachers and introducing them to new teaching methods, especially cooperative teaching methods.

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