
| RESEARCH ARTICLE

The Effectiveness of the Jigsaw and Traditional Teaching Methods on Math Anxiety, Attitude and Performance

Mohammad Zobair Azizi¹, Ahmad Atef² ✉ and Noorulhaq Seddiqi³

^{1,2,3}*Herat University, Assistant Professor, Faculty of Education, Herat, Afghanistan*

Corresponding Author: Ahmad Atef, **E-mail:** ahmad.atef1363@gmail.com

| ABSTRACT

This study was conducted to compare the effectiveness of cooperative learning on mathematics anxiety, attitudes towards mathematics, and mathematics performance of the 12th-class Private school students of Herat City by using a quasi-experimental study. The statistical population included 650 individuals who were all high school students. 40 individuals were selected in two 20-individual groups by the multistage cluster random sampling method. The Math Anxiety Scale (Baloglu & Zelhart, 2007), the Mathematics Attitude Scale (Fennema-Sherman, 2000), and teacher-made tests of mathematics academic performance were used to collect data. The Jigsaw cooperative learning model was used to monitor the effectiveness of the presence or absence of cooperative learning, and the data were analyzed using SPSS software and one-way covariance analysis (ANOVA). In this study, three hypotheses were formulated, and their results indicated that there is a significant difference between the Jigsaw cooperative and traditional learning models in terms of math anxiety, attitudes towards math, and mathematics performance of the 12th-class Private school students of Herat City. It is concluded that the Jigsaw cooperative learning model can be used as one of the effective methods in schools to reduce mathematics anxiety, foster a positive attitude towards mathematics, and enhance the 12th-class Private school students' mathematics performance.

| KEYWORDS

Mathematics anxiety, mathematics performance, mathematics attitude, jigsaw method, Herat City

| ARTICLE INFORMATION

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1. Introduction problem statement

Learning, teaching, and widespread application of mathematics in everyday life have become important global priorities for students and teachers (Steadly, Dragoo, Arefe & Luke, 2008). One of the best things about mathematics is that it can predict the economic success of a person in society (Steadly, Dragoo, Arefe & Luke, 2005). It is defined as the scientific relationships between numbers, space, and shapes, as well as a language associated with symbols that everyone uses. Mathematics is an important scientific field, and it is necessary to teach it in schools (Tezer & karasel, 2010). On the other hand, studies from all over the world show that the tendency of students to learn mathematics is very low. Today, in addition to mental abilities, special attention is paid to emotional variables such as students' anxiety and their perspective toward the lesson for the appropriate performance of students in mathematics. Active educational methods and learning have become interesting topics and have earned a special place in educational topics (Preinhard & Vallard, 2010).

In this research, the effect on the anxiety, attitude, and performance of students in mathematics courses is investigated using the jigsaw model, which is a collaborative teaching method (Kalaian & Kasim, 2014). Group learning methods are based on the theory of constructivism, which emphasizes the cooperation of learners with each other to achieve knowledge and understanding. Collaborative learning is one of the active teaching methods that refers to educational methods in which teachers organize students in small groups to work together in learning academic content and help each other in this matter (Slavin, 2011). Different

methods for collaborative learning have been identified, each of which has its own characteristics and advantages. The jigsaw method is an educational technique that was invented in order to develop the teamwork skills of learners. The jigsaw pattern invented by Elliott Aronson has been introduced as a cooperative pattern with a new application (Haghighat, Sabeti, Taheri & haghhighzadeh, 2014). With this model, students are required to gain complete proficiency in a part of the subject, and then they teach their learning to other members of their group. The advantage of the jigsaw model is that although the results of each student's effort are different from those of another student, it gives the necessary responsibility to all students with different abilities. In this method, students are divided into non-homogeneous groups, and then the groups in the class are given a topic to review. In the groups, the topic is divided into parts, and each part is divided among the students of the group. After gathering information, the students form specialized committees, and after participating in these groups, the students return to their groups and teach their groups. In their research, Haji Sadeghi and Saadatmand (2015) showed that teaching with a collaborative method has a greater effect on the academic progress of students compared to normal, individual, and competitive methods. Sepahrian Azar (2016) showed that the use of the jigsaw method in the chemistry classroom was effective in meeting the psychological needs of students and improving their performance compared to the control group.

One of the variables on which the effect of the jigsaw teaching method is scrutinized is math anxiety. Anxiety cannot be limited to what is defined as psychosis. One of the concepts related to anxiety in the field of learning is mathematical anxiety. Math anxiety appears as a state of discomfort when a student wants to do his math homework (Mohamed & Tarmizi, 2010). Educational experts have found that learners get emotional when dealing with learning issues. These emotions, especially if they are high, affect a person's academic performance. Although such emotions, which are known as anxiety, can be identified in different fields, since mathematics is more difficult than other subjects, math anxiety also has a special place for discussion and study (Sepahrian Azar & Mahmudi, 2014). Studies have shown that some teaching strategies create more anxiety in students (Hoyles, 1981; Quoted from Curtis, 2006). Hoyles (1981) states that students who had unpleasant math experiences showed higher math anxiety. They considered the origin of this anxiety to be caused by their teachers, lack of proper understanding of math concepts, and weakness in doing math assignments. On the other hand, research results such as those from Alsop show that the reduction of anxiety is directly related to the teacher's teaching style. Iro Smith, Marwa, Harjo, and Eppler (2003) emphasized that teachers should help students have a positive attitude and provide opportunities for students to succeed. Schmidt (2007), in research that investigated the anxiety and attitude of math students, showed that math anxiety was significantly reduced in collaborative classes. Another dependent variable studied is the attitude towards mathematics. Attitude is a nervous reaction, positive or negative, towards an abstract meaning or a concrete object. In other words, the concept of attitude is associated with the concept of feeling good or bad towards a person or thing. Therefore, the concept of attitude is associated with a positive or negative attribute (Karimi, 2010). Between 1924 and 1994, the attention of educational psychologists, including Fennema (1974), was drawn to the role of emotional motivational variables such as attitude on the academic performance of people, especially in the fields of mathematics and basic sciences. Attitude toward mathematics is a set of beliefs, feelings, and behaviors towards mathematics that are evaluated in three areas: self-confidence, importance, and gender belief in mathematics (Ghanbarzadeh, 2001).

In this regard, Phillips (1999) states that three factors in the common math classroom lead to a negative attitude toward math and create anxiety in students. As a result, the efficiency of the current methods has been questioned, including factors related to the teaching method, the imposed power of the teacher, public exposure, and time constraints. The same factors are the reasons for the high rate of academic failure of Iranian students at all levels of education in mathematics (Pahlevan Sadegh, Frad & Naderi, 2005). The proof of this claim is the results of the TEAMS 2 and TEAMS R-3 studies and Iran's ranking at the bottom of the table. While a new point of view in the teaching of mathematics lessons emphasizes more on structures, communication, discoveries, problem-solving skills, thinking, interpersonal relationships, and the spirit of cooperation, it aims to create a positive attitude towards mathematics, increase the ability to solve problems and improve academic performance in this course. The findings of Yilmaz, Alton, and Alkon (2010) show that math education based on real-life and life-enriched examples is effective in changing students' attitudes toward math. According to these views derived from the constructivist approach, mathematical knowledge is not an image representation of the external world but a map containing different ways of acting and thinking (Hall, 1994). Such a classroom environment provides opportunities for students to search for and discover constructivism processes. In this environment, students are faced with hands-on learning, discussion, and group work. It is in such an environment that teachers pay attention to the presence of others and how students interact with each other (Curtis, 2006). Concerning the necessity of the present study, it should be said that although much research has been done in other countries about the collaborative model of the jigsaw in different courses, disciplines, and levels of study, the positive effects of this approach have not been investigated. Unfortunately, in our country, especially, its effect on psychological variables has been neglected. Many questions in this direction need to be examined, and numerous research studies need to be conducted. The current research tries to answer the question of whether the collaborative learning model of Jigsaw reduces math anxiety and improves students' attitudes and performance in math lessons.

2. Research Methodology

The current research method is practical and semi-experimental, and a pre-test and post-test design with a control group has been used. Jigsaw and traditional teaching methods have been studied as independent variables. Math anxiety, attitude, and math lesson performance have been studied as dependent variables. The statistical population of the present study included all 12th-class private school students in Herat City, who were 650 people in the academic year 2023–2024, according to the reported statistics of Private Schools. Due to the semi-experimental nature and because the statistical population was very wide and included all 12th-grade students at Private schools, Selecting the sample by other sampling methods required workforce time and high cost; multi-stage cluster random sampling was used. To access the target sample, two schools from Herat City and then two classes were randomly selected from each school. The research sample was 40 students (20 people in the experimental group and 20 people in the control group) who were selected by multi-stage cluster random sampling.

In this research, a questionnaire tool was used to collect information. Each of the questionnaires is described below:

1. **Mathematical Anxiety Scale:** The revised math anxiety scale was developed by Richardson and Sain in 1972 with 25 questions, which was reduced from 25 items to 20 items in 2007 by Baloglu and Zell Hart using factor analysis. The five-option Likert scale is designed as never, a little, somewhat, a lot, and a lot, with scores from one to five. This questionnaire was translated into Farsi by Rajabi and Harizadeh. In order to standardize the revised math anxiety scale, Plaque and Parker implemented it on 170 mathematics students and the alpha coefficient of the learning anxiety scale was (0.90) for the measurement anxiety subscale (0.89) and for the whole scale was (0/92). In addition, Rajabi and Harizadeh reported a value of 0.89 using Cronbach's alpha for this questionnaire, which indicates the appropriate reliability of this tool.
2. **Mathematics Attitude Scale:** To measure mathematical attitude, the Revised Fenma Sherman Math Attitude Scale (2000) is used. This questionnaire was first prepared in 1986 by Fenma and Sherman and was revised several times. In this research, the latest revised version (2000) is used. The questionnaire consists of 18 questions and three components: confidence in one's ability to do math problems with questions 1 to 6, perceived usefulness of mathematics with questions 7–12, and perception of the teacher's attitude with questions 18–13. The rating of the questionnaire is on a 5-point Likert scale, from "completely agree" to "completely disagree," with a score of 5 to 1. So, the sum of the values obtained on each scale was considered as a person's attitude toward mathematics; in this way, the scores of the respondents, after aligning the items through recoding, were placed between the possible ranges of 18 and 90. A high score for each respondent indicates a positive attitude towards mathematics, and a low score indicates a negative attitude towards mathematics. The validity and reliability of the Fenma Sherman Mathematical Attitude Scales have been investigated in numerous research studies.
3. **Teacher-made test of academic performance (mathematics lesson):** A teacher-made test was used to measure this variable. In this regard, the opinions of the heads of the mathematics course and two mathematics teachers were used to confirm the validity of the test, and the test score was 20. So, the scores of the students' previous year were considered a pre-test. The reliability calculated in this research for the math anxiety questionnaire through Cronbach's alpha is 0.724, for math attitude through Cronbach's alpha is 0.682, and for the teacher-made test of academic performance through correlation is 0.679, and these values are at an acceptable level. After obtaining the necessary permits from the school director, all the students who were trained in 2 classes in groups in the traditional way were first asked questions about math anxiety and math performance tests made by the teacher, and between 40 Students whose grades were average and low were selected as the sample size and were categorized into two experimental and control groups. In the next step, the members of the sample in the experimental group continued their math teaching with the participation-oriented approach using the jigsaw method (20 people) in the experimental group and 20 people in the control group using the traditional method of teaching mathematics. The intervention of the math education method with the participation-oriented approach with the jigsaw method was implemented for 12 group sessions (two sessions per week) in the form of 40-minute sessions in the experimental group. After finishing the sessions, post-tests were taken from the students of the experimental and control groups, and the collected results were analyzed by observing the assumptions (regression slope and Levin tests as the assumptions of the analysis of covariance).

3. Research findings

The results of the study showed that the average and standard deviation of the age of the participants in the current study were 13.65. Considering that the aim of the present study was to compare the effectiveness of jigsaw and traditional teaching methods on math anxiety, attitude towards math, and math lesson performance, The average and standard deviation of the dependent variables studied in the two stages of the pre- and post-test are presented in the table below.

Variable	Test Steps	Group	Mean	Std. Deviation
Math Anxiety	Pre-test	Experimental	44.37	8.20
		Control	40.05	9.46
	Post-test	Experimental	32.13	6.52
		Control	39.43	7.54
Attitude towards Mathematics	Pre-test	Experimental	63.63	5.62
		Control	69.30	6.91
	Post-test	Experimental	73.50	4.20
		Control	70.97	5.11
Mathematics Performance	Pre-test	Experimental	11.25	2.77
		Control	10.58	4.33
	Post-test	Experimental	16.16	3.33
		Control	11.66	3.78

Table 1: The research Descriptive statistics of Variables

Before using the parametric test of covariance analysis, the Kolmogorov-Smirnov normality test, Box test, and Levin test were used to comply with its defaults. The results of checking the normality of the data showed that the z-statistic of Kolmogorov-Smirnov for the studied variables is not significant at the level ($P < 0.05$); that is, the distribution of the variables among the sample is normal with its distribution in the statistical population. In addition, the results of the box test showed that the level of significance was not significant for any of the components of the dependent variables. The condition of homogeneity of the variance and covariance matrices is correctly met. Also, based on Levine's test, the level of the statistic (F) for the components of the dependent variables is not significant, and this indicates that the error variance of these variables is not different among the subjects, and the variances are equal. Also, the results of the analysis of the equality of the slope of the regression line as the assumption of covariance analysis showed that the significance level of the line of interaction between the pre-test of the studied variables and the group is greater than 0.50. Therefore, the regression homogeneity hypothesis is accepted.

Source of change	Sum of Squares	df	Mean square	F	Sig
Pre-test	592.25	1	592.25	14.71	0.000
Group	638.49	1	638.49	15.86	0.000
Error	229.47	57	40.25		
Pre-test	272.77	1	272.77	15.59	0.000
Group	249.41	1	249.41	14.25	0.000
Error	997.58	57	17.50		
Pre-test	415.45	1	415.45	73.34	0.000
Group	239.15	1	239.15	42.22	0.000
Error	322.78	57	5.66		

Table 2: The covariance test for the Jigsaw and traditional teaching Methods

The results of covariance analysis, which can be seen in Table 2, indicate the significant effect of jigsaw and traditional teaching models on math anxiety, attitude towards math, and students' math performance. Also, the obtained results show that the difference between the jigsaw and traditional teaching models on math anxiety, attitude towards math, and math performance is significant.

4. Conclusion

The mathematics lesson is undoubtedly one of the most important lessons that students need to know and understand at all levels of education. Many students, for various reasons, such as the teacher's teaching method, unsuccessful experiences, pressure from parents, lack of practice, and difficulty in learning math concepts, are so afraid and anxious about this course that they show

resistance, saying that sometimes they cannot even do the simplest math exercises. Today, due to the dominance of mathematics over new science and technology, there is a greater need to learn this science and understand its laws. Therefore, what teachers need to know is to simplify the concepts, emphasize the basic principles of mathematics, and provide various exercises and examples. Math anxiety causes mental weakness in performing math exercises and causes negativity and confusion in students. This group avoids learning this lesson by avoiding math class because of their inability to do math tests.

The results of the covariance analysis in the present study show that the difference between the jigsaw and traditional collaborative learning models in terms of math anxiety is significant. In research that investigated the anxiety and attitude of math students towards math lessons, the results showed that math anxiety was significantly reduced in the cooperative class, which is in line with the findings of this research. According to Eysenck, the harmful effects of anxiety on performance are attributed to inappropriate task processing activities, such as worry (the cognitive component of anxiety). Students who report high levels of anxiety tend to perform poorly on exams and have below-average grades. Gillis believes that when students work cooperatively with each other, they show more activity in group discussions, they discuss with each other at high levels of discussion, and they listen well when others speak. Rationally, they create a more valuable partnership that is in line with the results of this research. In explanation, it can be said that the new and advanced theories of cooperative learning state that learning is effective when the learner has the main role. The teacher should be a guide and try to involve the students in the class activities as much as possible in different ways.

Also, the results of the covariance analysis showed that the difference between the jigsaw and traditional collaborative learning models on math attitudes is significant. The results of Gholamali Lavasani's research showed that the collaborative learning method significantly increases the use of help-seeking strategies in students and reduces math anxiety and avoidance of help-seeking in students compared to the traditional method, which is consistent with the findings of this research. In this regard, Millis reached a conclusion in her research that collaborative learning in math class reduces math anxiety. Holzdom and Lutz have reported that the implementation of the exploratory teaching model has been effective in improving student performance and developing attitudes and skills. They have also stated that, as a result of students' participation in exploratory programs, their grades, attitudes, processes, and analysis skills have increased significantly. It indicates that in order to improve math attitudes, we should pay attention to the role of motivational factors, especially math attitudes, and push math teaching methods in the direction of creating interest in this subject. Yinilmaz, Georgina, and Ozon found a strong relationship between high motivation, a positive attitude, and low anxiety and math performance. Therefore, emotion is a very important subject in teaching mathematics and can cause factors such as anxiety and fear of mathematics, enjoyment of mathematics, self-confidence in mathematics, and success and failure in mathematics. Also, Aiken and Lewis showed that math attitude predicts academic success in math, which is in line with the findings of this research. In another study, the National Council of Mathematics Teachers in the United States and Canada mentioned that the best way to teach mathematics is for students to construct mathematical concepts themselves. This council has emphasized the game as an effective method of teaching mathematics to elementary school and preschool children, and the findings of Yilmaz Alton and Alkun show that mathematics education with regard to real-life and life-enriched examples affects students' attitudes towards mathematics.

According to the researcher, the obtained results are reasonable. Involving students, taking advantage of students' opinions and viewpoints, and asking questions and answers in the teaching process from students leads to a positive attitude towards mathematics in students, which requires the educational system of the country to provide a suitable scientific platform for using the Jig-Saw collaborative learning teaching method. For teachers to become more familiar with this active teaching method in order to strengthen the students' positive attitude towards mathematics, the learning situation and its environment are very effective factors in learning.

Finally, the results of the covariance analysis show that the difference between the jigsaw and traditional collaborative learning models on the performance of the math course is significant. In research, it was concluded that collaborative learning has a positive effect on students' attitudes towards mathematics and their academic progress in this subject, which is in line with the findings of this research. Also, Kindt et al. reviewed the studies that were conducted on the effectiveness of cooperative learning on the three results of progress, attitude, and perception of learners. Their results revealed the positive effect of collaborative learning on progress and attitude. Al-Khatib and Juma's results also showed a significant difference between the performance of students in the collaborative and traditional learning groups. Shojaei's results showed that teaching by the jigsaw method increased the academic achievement of the experimental group.

The statistical population is limited to the students of Sardasht city. The differences between the subjects in terms of economic, cultural, social, and family conditions and the limited sample of 12th graders were the limitations of the present study. Considering the effectiveness of the collaborative jigsaw learning model with the traditional learning model on anxiety, attitude, and performance of math lessons, this model is suggested for 12th grade students. Efforts to build mutual trust between teachers and

students in order to optimally use the jigsaw collaborative teaching method and reduce math anxiety; Free choice of a group of mathematical problems and assignments to engage students and guide them to choose problems that are both attractive and challenging for students to do in groups. The use of experienced teachers familiar with active teaching methods, especially Jigsaw collaborative learning, is suggested.

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