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Effectiveness of teaching: Jigsaw technique vs. lecture for medical students' Physics course

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ABSTRACT

Background: Cooperative learning considered as one of the greatest innovations in the educational system. Jigsaw learning technique, one form of cooperative learning method, has been successfully used to improve academic achievement among students. The present study was conducted to compare the effectiveness of jigsaw technique with lecture-based teaching method for medical students' physics course.

Methods: A pretest was performed on the students to ensure their literacy. Relevant topics, i.e. bioelectricity (first subject) and application of electricity for diagnosis and treatment (second subject) were then presented to the two groups using mentioned methods. A questionnaire with a confirmed validity and reliability and a posttest were used to measure their learning and assess whether it was satisfactory or not.

Results: The mean posttest scores differed significantly between the two groups ($p < 0.001$ for subject 1 and subject 2). More than 80% of the participants agreed or agreed with all the items that assessed their satisfaction with what they had learned in Jigsaw class. However, some of them were concerned about the sufficiency of their learning and their final score.

Conclusions: Jigsaw learning technique is recommended as a proper method for teaching physics if the students' concern about their final score can be resolved and the accuracy of the information conveyed to them is ensured.

Keywords: Cooperative learning, Jigsaw technique, Teaching Methods, Physics course.

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INTRODUCTION

Education institutions have a key role in training a knowledgeable and skillful generation, and their effectiveness depends greatly on the methods of education they choose to teach their students. The lecture method of teaching is focused on hearing as the means of learning and can only be effective by 13%.[1]

A good teaching method exposes the learners to challenging situations and provides them with opportunities for interaction, consultation, cooperation, discussion, and debate with themselves and their teacher so that they can develop their power of thinking and participation. One of the most important objectives of an education system is to help develop the power of thinking and create a meaningful learning experience in learners. When a learner can link newly-gained to previously-acquired information, his learning experience can be said to be meaningful. This view on learning and teaching, however, is in contrast with the unilateral transference of knowledge from the teacher to the student.[2-4]

Studies on the Iranian education system suggest that Iranian teachers have often used conventional methods of teaching. Promote the mere duplication of information, use only lectures, and often resist switching to new methods of teaching, and if at times, teachers have become more inclined to use these new methods, they have mostly failed to implement them or base them on scientific evidence properly.[5,6] It is therefore necessary to further examine the modern methods of education and their correct application.

Cooperative learning is a method of education that has gained a lot of research interest in recent years so that it is called as one of the greatest innovations in the educational system. Cooperative learning is a method of education in which the learner is responsible not only for his learning but also for the learning of others. The learners work in small groups to help one another learn the educational content, carry out group projects and master different subjects by cooperating and consulting with their peers and transferring their knowledge to them.[6-10] The main approaches to cooperative learning used in recent decades include Student Team Achievement Divisions (STAD), Team-Games-Tournaments (TGT), Team Assisted Individualization (TAI), and jigsaw. These methods differ in terms of their structure and the type of learners' responsibilities involved. In some of these approaches, the learners may do their tasks

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as a group, while in other approaches, the tasks are divided among the members of a group, and each member works independently and only asks for help if needed.[6,8,10]

Jigsaw learning technique or jigsaw puzzle constitute a well-structured cooperative learning technique that is free from many of the problems involved in other learning methods. This and other innovative teaching and learning techniques have been successfully used to improve academic achievement among students. The jigsaw technique is based on the philosophy that learning develops best when the subject of study is also taught to others once it is acquired.[6,11-14] In the jigsaw technique, learners are divided into matching groups of four or six. The lesson is then split into the number of persons in each group. Using this classification method means that the content of one part cannot be a prerequisite for any of the other parts and each part should be independent of the other parts while also covering the lesson plan together. A number is assigned to the members of each group as well as to each subject. For example, subject one is assigned to the person one in each group, subject two to person two and so on. Temporary groups will then be formed. All the members of each temporary group (also called an expert group) work on the same subject; for example, they all work on subject two of the class material. The expert groups consist of three to five members who study and discuss the subjects assigned to them and exchange ideas to gain expertise in them and so that they can explain the subject to other members of the main jigsaw groups. The teacher and learners agree on a set time, and the learners then return from the expert groups to their associated jigsaw group and teach the subject thus learned to the other members of their group and are also taught all the other subjects learned by the other members of their group. Using this method of teaching provokes the learners' interest in the lessons and improves the social relationship between them.[11-13,15,16] In this study, the jigsaw technique was chosen as the select method of teaching, and its effectiveness on the students' acquisition of physics was compared with lecture-based teaching at Gonabad University of Medical Sciences.

MATERIALS AND METHODS

The present quasi-experimental study was conducted on the entire population of clinical laboratory sciences and public health students at Gonabad University of Medical Sciences taking the same course in physics in the first semester of the academic year of 2015-2016. The sample size was 34 overall consisting of 18 laboratory sciences students, who were assigned to group 1 and 16 public health students, who were assigned to group 2. Teaching was based alternatively on the jigsaw technique and lecture method. The class prerequisite included topics on electricity, which was first taught to the students through a lecture-based method over one session. Both groups took a pretest to ensure they were matching in their literacy. The subjects taught in this study included bioelectricity (the first subject) and the application of electricity for diagnosis and treatment (the second subject).

The jigsaw technique was used to teach the first subject to group 1 and lecture method to teach it to group 2. To teach the second subject, however, the jigsaw technique was used in group 2 and lecture method in group 1. This arrangement ensured that the lessons were taught in a crossover manner. In each case, the subject that was supposed to be taught using the jigsaw technique was split into sections of equal difficulty with no overlaps, as in accordance with the requirements of the jigsaw technique. Every student received a sheet of paper containing details of the subject they needed to master, a series of information about it and proper references to be studied. Expert groups were then formed to discuss and exchange ideas on the subject assigned to them in a matter of 25 minutes. Each member of the expert groups then returned to their initial groups and taught the part assigned to them to the other members of that group. Performing this task took 80 minutes. At the end of the training session, the students took a final test to have their level of learning measured. Before taking this test, however, both groups completed a 12-item researcher-made questionnaire on satisfaction about the jigsaw technique for teaching. A Cronbach's alpha of 0.91 confirmed the validity and reliability of this questionnaire.

The data collected were analyzed in SPSS-14 at a significance level of $P<0.05$. Absolute and relative frequency were used to analyze the qualitative variables and mean and standard deviation to measure the quantitative variables. The Kolmogorov-Smirnov test was used to determine the normal distribution of the data. The independent t-test and the paired t-test were used respectively to compare the means of the quantitative variables between and within the two groups for both teaching methods. Fisher's Exact Test was used to compare the two groups in terms of gender.

RESULTS

No significant differences were observed between the two groups in terms of gender, semester grade point average (GPA), and the mean pretest score; however, the groups were significantly different in terms of age (Table 1).

Table1 Comparison of demographic variables between two groups

Variables		Laboratory Sciences (n = 18)	Public Health (n = 16)	p-value
Age (years), mean ± SD		21.77 ± 3.04	26.18 ± 3.46	< 0.001
Gender	Male, n(%)	7 (38.9)	6 (37.5)	0.607
	Female, n (%)	11 (61.1)	10 (62.5)	
Semester GPA, mean ± SD		15.83 ± 1.09	15.91 ± 1.41	0.851
Pretest, mean ± SD		15.97 ± 1.52	15.68 ± 1.74	0.615

Table 2 Comparison between posttest scores for two groups and subject 1 and 2

Material	Method	Laboratory Sciences (n = 18) Mean ± SD	Public Health (n = 16) Mean ± SD	p-value
Subject 1	Jigsaw-Lecture	18.80 ± 1.27	14.78 ± 2.31	<0.001
Subject 2	Lecture-Jigsaw	15.25 ± 2.52	18.28 ± 1.12	<0.001
		<0.001	<0.001	-

As shown in Table 2, the posttest score obtained in subject one differed significantly between the two groups. The group of laboratory sciences students, who were taught this subject using the jigsaw technique, showed a significantly better mastery over the subject compared to the group of public health students, who had received training on this subject through lectures ($p < 0.001$). Similarly, the posttest score obtained in subject two in the group of public health students, who were taught this subject using the jigsaw technique, showed a significantly better mastery over this subject compared to the group of laboratory sciences students, who had received training on this subject through lectures ($p < 0.001$). Furthermore, the group of laboratory sciences students received significantly higher scores in subject one, which was taught to them using the jigsaw technique, compared to the scores received in subject two, which was taught to them through lectures ($p < 0.001$). Also, this result was likewise established for group two.

A vast majority of the students (92.2%) agreed or agreed that the jigsaw technique is useful. A total of 88.2% expressed their satisfaction with the jigsaw technique compared to the lecture method, and 85.3% agreed or definitely agreed about feeling less fatigued in a jigsaw based class than in a lecture-based one. A total of 91.1% of the students identified jigsaw-based learning as more profound than lecture-based learning, and 88.2% stated that they were more interested in learning physics through jigsaw. A total of 94.1% of the students agreed or definitely agreed that learning physics was more enjoyable with the jigsaw technique, and 97% agreed or definitely agreed that the jigsaw technique led to a better collaboration among the students compared to the lecture method. A total of 94.1% of the students agreed or definitely agreed that the jigsaw technique leads to a greater retention of information by the learners and their greater attention and focus in the classroom, compared to lecture-based classes. Nevertheless, 64.7% of the students were concerned about the accuracy of the information they had received through jigsaw activities, 26.5% disagreed or definitely disagreed that the information. Thus received was as adequate as the information received through lectures, and 50% were concerned about their final score when using jigsaw technique to learn class material.

DISCUSSION

The results obtained in the present study indicate the effectiveness of cooperative learning through jigsaw learning technique for the subject of physics among students at Gonabad University of Medical Sciences, as the students received higher scores when the jigsaw method was used than when they had only attended lectures. Keramati et al.[5] found that cooperative learning leads to a better academic achievement in the subject of physics compared to conventional learning methods. Based on the results obtained, cooperative teaching is highly recommended for teaching physics classes, although its use for teaching other subjects should be further discussed.

Maftel et al.[17] found that jigsaw activities lead to a satisfactory learning of atomic physics, particularly laboratory subjects in the field, in high school students. The effectiveness of Jigsaw technique on enhancing the students' knowledge was investigated for various courses such as principles and methods of teaching course,[18] English language course,[19,20] chemistry course[21] and family and consumer sciences.[22] All of the mentioned studies suggest Jigsaw as a useful technique. Hanze and Berger[23] compared the Jigsaw classroom of cooperative instruction with traditional direct instruction in 12th grade Physics class. While no differences were found between two conditions for Physics achievement gains, the results revealed differences in students' experience of three basic needs including autonomy, competence, and social relatedness. Therefore despite the fact that this study failed to show the positive effects of Jigsaw puzzle on academic performance, it confirms other benefits of Jigsaw learning technique.

As mentioned in the introduction section, creating a meaningful learning experience is a major goal of teaching. Especially in the case of medical students studying subjects in physics, because these students rarely use their physics knowledge

directly once they graduate. Although the knowledge of physics is the basis of their understanding of specialized subjects in their field of medicine; therefore, if they fail in a physics course, they will be faced with serious challenges in their workplace after graduation. Furthermore, given the extensive list of courses in physics in medical sciences curricula in Iran and considering that the majority of medical students do not have a strong knowledge of physics at the introductory level, teachers inevitably become the only speakers in most lecture-based physics classes. The increased fatigue and boredom among the students is thus a serious challenge for teachers. Lecture-based teaching reduces the students' attention to the subjects taught and therefore decreases learning efficiency. Although jigsaw activities are a time-consuming technique, the majority of students feel less tired with their use in the class.

The lack of enthusiasm and interest in physics can be a serious challenge faced by medical students. The use of conventional teacher-centered teaching methods in high schools, especially for teaching a dynamic lesson such as physics, can be regarded as one of the main factors contributing to the lack of interest in this subject in first-year students at universities. The teacher has to be crafted enough to eliminate and even transform this indifference into enthusiasm. The present study found that applying cooperative learning can be a major step towards achieving this goal. In addition, 94.1% of the students in the present study responded 'yes' to the item of 'Jigsaw has enhanced my interest in physics'.

The students' concern about the accuracy of the materials learned through the jigsaw technique (67.4%), the adequacy of training through this method (73.5%), and the potential nonconformity between the data exchanged in the different groups (50%) are points that need to be further discussed. The students' concerns about these issues can be resolved through the teachers' introduction of a comprehensive reference about the educational goals of the jigsaw technique. Studying this reference can ensure the students of the accuracy and adequacy of learning through jigsaw activities. The students can also consult with their teammates, members of the other groups or their course instructor for solving any potential problems. The significant age difference observed between the two groups and the success of the jigsaw technique in both groups proves that this technique can be helpful irrespective of age. In other words, based on the results obtained in the present study, age does not affect the efficiency of jigsaw technique.

CONCLUSION

Overall, the present study suggests that, as a cooperative approach to learning. The jigsaw technique is more useful for teaching than lectures; the superiority of this technique lies in its enhancement of the learning experience and the provocation of the students' interest in physics, the creation of an atmosphere of interaction and cooperation between the students and teachers, and the near elimination of fatigue from classrooms. Based on the present findings and the results of similar studies on the subject, this learning technique is recommended for teaching physics to medical students based on the accurate principles described in this study. Time constraint is one of the challenges of using the jigsaw technique; as performing jigsaw activities in a class can be time-consuming, proper time management by the teacher is absolutely necessary.

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