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The effect of cooperative learning model on academic achievement in physics

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Abstract

The aim of this study is to determine the effect of reading-writing-presentation technique on students' academic achievements in teaching of "Force and Motion" from general physics course. The sample of this study consists of 66 under graduate science teachers during the 2010-2011 academic years. As the data collection instruments, Graphic Test (GT), Academic Achievement Test (AAT), Module Tests (Module A, Module B, Module C, Module D and Module E) and Semi-Structured Interview (SSI) were used. This study was carried out in two different groups. One of the groups was selected randomly as the Reading-Writing-Presentation Group (RWPG) and the second was selected as the Control Group (CG), in which teacher-centered instruction was applied. The data obtained on instruments were evaluated by using independent samples t test and content analysis. The results of this study indicate that teaching of "Force and Motion" subjects in RWPG was more effective than the CG and also, students have positive opinion about this technique.

Keywords: Reading-writing-presentation; Force and Motion; Science and Technology.
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1. Introduction

Constructivism is the dominant perception of the developments in today's educational system has brought some innovations. Especially, student-centered education is taken to forefront and emphasized on new methods and techniques and students have been made to understand issues at the highest level. The main objectives of the education system must be gain to students using their skills for access to information, not transfer to them the available information. Science lessons are very important to get also these skills for students [1-3]. Especially, science lessons have lots of abstract concepts so in teaching of science it's preference that by doing and living applications, so that students don't passive in their own

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learning effectively [4]. In contrast to teacher-centered teaching methods, student-centered teaching methods regard the students as active learner. Previous research stated that student-centered teaching methods are more effective than traditional teaching methods [5-7].

Physics is one of the science lessons and it is a discipline that based on qualitative and quantitative measurements for understanding the natural phenomena around us [8]. Students have difficulty in learning physics because physics is composed more abstract concepts [9, 10]. Many studies were conducted about physics subjects especially "Force and Motion" to understand much better by researchers [11-16]. It's shown from Hart's [17] study that the concept of "force, "restoring force", "gravity" and "friction force" are a lot of mistaken concepts. Similar situation is also valid for "weight", "motion", "energy" as well as other concepts that correlated with the concept of the force [18-20]. In addition, students have some misconception about "Force and Motion", for example; students confuse between the height and the slope of the position-time graph, force is directly proportional to speed, not acceleration, motion implies force, although the total force acting on an object is zero, the speed is decline, there is a linear relationship between force and velocity, the unit of weight is kilograms, etc. [21, 22].

Therefore, it's clear that new methods and techniques are needed to provide a much better understanding the subject of "Force and Motion". Particularly, methods and techniques which make students more active in their own learning is the forefront in education [23, 24]. One of these methods is cooperative learning that is an important take part in today's education. It has been concluded that many science researches related to cooperative learning method is more effective on students' achievements [3, 25-27].

Cooperative learning is a learning method that students assigned to small groups in the classroom as well as other environments and in which they help each other in order to learn with together, students achievement's increase more and also develop self-confidence of individuals, develop communication skills and the students participate actively in this method [28]. This method is applied with different techniques in education. The forefronts of these techniques are: Learning Together, Student Teams, Group Investigation, Let's Ask and Learn Together, Jigsaw and Reading-Writing-Presentation (RWP) technique. In this study, the RWP technique was used.

In RWP technique, firstly taking into account the physical condition of the class where the course is processed, the number of students, students' academic achievements and students are divided into heterogeneous groups that consist of 2-6 members in class. This technique provides to students work individually and with groups from different sources, to create a positive interdependence, the configuration of the new information on the available information, to increase the social and psychological skills. In addition, it's aimed to develop students' reading, writing and presenting skills.

The purpose of this study is to investigate the effect of reading-writing-presenting activities and traditional teaching methods on students' understanding of "Force and Motion" in an undergraduate physics course.

2. Methodology

2. 1. Sample

The sample of this study consisted of a total of 66 undergraduates from two different classes enrolled in the general physics course for the 2010–2011 academic years. One of the classes was defined as the Reading-Writing-Presentation Group (RWPG) (n=34) and was

taught by the Reading-Writing-Presentation technique, while the Control group (CG) (n=32) was taught through teacher-centered instruction. Pre-service science teachers are admitted to this department only after they have successfully passed a university entrance exam. The mean age of the participants was 19.23 (SD=1.38). Neither age nor gender differed significantly among the groups. Ages ranged from 18 to 23 years. Volunteers were given background information regarding the study prior to consent. During the training period, instruction for both groups was delivered by the researchers.

2. 2. Instruments

In this research, the Academic Achievement Test (AAT), Graphic Test (GT), Module Tests (MT) and Semi-Structured Interview (SSI) were used.

The AAT consists of 20 multiple-choice questions and each question worth is five points. This test was created by the researchers. The questions in the test were related to the concept of force and Newton's laws, types of force, motion, and the concept of variables, including issues of motion in one dimension and two dimensions of "Force and Motion". This test was given to students who were not involved in the study but had previously taken the course in which the "Force and Motion" topics mentioned above had been taught. With respect to reliability, AAT was administered to a group of 42 students who had taken the General Physics course the year before. The KR20 was used to determine the reliability of AAT and the reliability coefficient was found (α= 0.607). Moreover, to check the validity of the AAT developed the opinions of Physics lecturers and researchers on the subject were taken into consideration. Researchers pointed out that the gains achieved with AAT related to the subjects of "Force and Motion" had been high in terms of the measurement.

The GT consists of 25 multiple-choice questions and each question worth is four points. The GT was designed to assess the reading and understanding of graphics used in physics. The GT was created by the researchers. The questions in the test were related to the reading, drawing, and understanding of graphics in physics courses. The validity of the test was checked by a professor and two other physics teachers. With respect to reliability, the GT was administered to a group of 42 students who were not involved in the study but had previously taken the course in which the general physics courses mentioned above had been taught. The KR20 was used for determining the reliability of GT, which was found to be α= 0.757.

The MT was composed of four multiple-choice questions and one open-ended question. Multiple-choice questions were piloted with undergraduates from two classes of college physics. Item analyses were performed for each question and confusing or vague questions were rewritten before the test was used in the study. The open-ended questions were evaluated according to quality analysis.

The content of SSI was prepared to consist of ten semi-structured interview questions. The main purpose of content analysis is to reach collected data that can be explained the concepts and relationships [29]. Each interview took 20-30 minutes at conversation banter. The queried subjects at semi-structured interview are below.

1. What do you think about reading-writing-presenting technique for students' participation in the course?
2. Do you think reading-writing-presenting technique attract students' attention? Is it caused to increase interest of students in to the lesson?
3. Do you think the academic achievement of students has increased as a result of reading-writing-presenting technique?

4. What do you think about whether reading-writing-presenting technique increases students' interests to study subject?
5. What do you think about the effects of reading-writing-presenting technique on students' intergroup communications with their friends strictly?
6. Do you find reading-writing-presenting technique sufficient to ensure the needed time for understanding the subject?
7. Do you find this technique sufficient to students in terms of express themselves in class?
8. Do you think that reading-writing-presenting technique is useful for provide to social addiction and provide to continue the lesson?
9. What do you think about the implementation of reading-writing-presenting technique in physics lesson? Do you think it's also applied in to the other lessons?
10. What are the negative aspects of this technique implementation?

2. 3. Procedure

In the treatment groups, this study was conducted over a five-week period during which the "Force and Motion" unit was taught as part of the regular curriculum in the general physics course. After the study is completed, Semi-Structured Interview was conducted with the Reading-Writing-Presentation Group.

2. 3. 1. The Reading-Writing-Presenting Implemented

The RWPG students were randomly divided into seven sub-groups as shown in Fig. 1. In this instance, six groups were contained five students and one group contained four students. The reading-writing-presenting technique was carried out five weeks to teaching the "Force and Motion" unit. The main features of the modified reading-writing-presenting technique are presented in three phases for each group in given Fig. 1 and namely; 1) in-class reading, 2) in-class writing, and 3) in-class presenting

In class reading; all groups in the classroom read the topics for 30+30 minutes from the course books or other resources which was included in the module for the week.

In class writing; all groups wrote their understanding about what they read for 50 minutes without accessing resources. Writing was done by group pairs. After finishing the writing, the notes written by the groups were evaluated by the author. Groups whose evaluated outcomes were not good enough sent back to groups for reading stage.

After the groups finished reading and writing stages, all groups made presentations about the subject for 20 minutes. Then, after the presentation an argument discussed in the classroom.

2. 3. 1. Implementation of teacher-centered teaching method

In the control group, the subjects were taught by using the teaching-centered method. The researchers planned the presentation activities of the subjects that would be taught during the lesson in a report not by a classical teaching presentation but by giving assignments to students on the subjects of "Force and Motion", and by providing internet addresses and workbooks for constructing the information to be presented to them. The same content was taught in the cooperative groups and the learning objectives were the same. In contrast with the RWPG, students in the control group were required to use their textbooks; students were

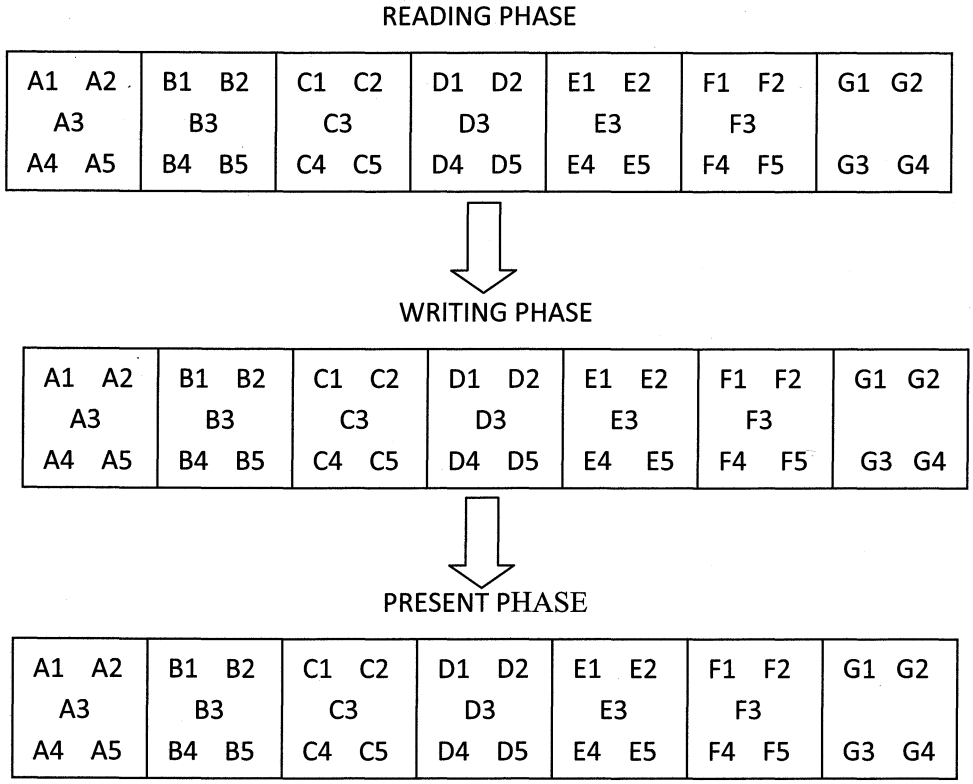


Fig. 1. Phases of reading-writing-presenting technique.

passive participants and rarely asked questions. In the teaching-centered method, generally the teacher wrote the concepts on the board and then explained them; students listened and took notes as the teacher lectured on the content. In this process, student's performances were observed and the studies were directed according to the feedback obtained from them. "Force and Motion" topics were taught by the authors to the treatment groups four hours per week for five weeks. Measurement tools were applied to the treatment groups at the end of the study.

3. Findings and discussion

Independent sample *t* test of data obtained from AAT, GT, and MT in the treatment groups are enclosed in Tables 1, 2 and 3, respectively.

Table 1. Results of the independent sample *t* test analysis of multiple-choice questions of the AAT pre-test and post-test

Tests	Groups	N	Mean	*SD*	*t*	p
Pre- test	KG	32	39.69	12.568	0.143	0.887
	OYSG	34	40.15	13.511		
Post- test	KG	32	50.47	9.534	7.159	0.00
	OYSG	34	65.59	7.564		

It was determined that the scores of the arithmetic average of the pre-test achievement was 40.15 and the standard deviation was 13.511 in the RWPG, the scores of the arithmetic average of the pre-test achievement was 39.69 and the standard deviation was 12.568 in the

CG when the table is investigated. Prior to treatment, t-test was performed to investigate whether there was a significant mean difference between the RWPG and CG with respect to students' pre-test scores. The results revealed that there was no significant difference between control group and experimental group ($t = 0.143$; $p > 0.05$). The results of this analysis show that the levels of success in the control group and experimental group are closer to each other at the beginning. It was determined that the scores of the arithmetic average of the post-test achievement was 65.59 and the standard deviation was 7.564 in the RWPG, the scores of the arithmetic average of the post-test achievement was 50.47 and the standard deviation was 9.534 in the CG after the application of prescribed methods to both groups. After the treatment, the analysis results showed that there was a significant difference between the post-test mean scores of the students taught by reading-writing-presenting and those taught by traditional method ($t = 7.149$; $p < 0.05$). So the RWP techniques' scored significantly higher than the teacher-centered method.

Table 2. Results of the independent sample *t* test analysis of multiple-choice questions of the GT pre- test and post-test

Tests	Groups	N	Mean	*SD*	*t*	p
Pre- test	KG	32	29.00	9.087	1.00	0.321
	OYSG	34	31.35	9.975		
Post- test	KG	32	42.50	9.242	6.216	0.00
	OYSG	34	56.47	9.013		

As seen at Table 2 , it was determined that the scores of the arithmetic average of the pre-test of GT achievement was 31.35 and the standard deviation was 9.975 in the RWPG, the scores of the arithmetic average of the pre-test achievement was 29.0 and the standard deviation was 9.087 in the CG. The results revealed that there was no significant difference between control group and experimental group ($t = 1.00$; $p > 0.05$). The results of this analysis show that the levels of success in the RWPG and CG are closer to each other at the beginning. And the scores of the arithmetic average of the post-test achievement was 56.47 and the standard deviation was 9.013 in the RWPG, the scores of the arithmetic average of the post test achievement was 42.50 and the standard deviation was 9.242 in the CG after the application of prescribed methods to both groups. After the treatment, the analysis results showed that there was a significant difference between the post test mean scores of the students taught by reading-writing-presenting and those taught by traditional method ($t= 6.216$; $p < 0.05$). So the RWP techniques' scored significantly higher than the teacher-centered method.

Module tests were prepared for each sub-heading of force and motion subjects and these were Module A (the concept of force and Newton's laws), Module B (varieties of force), the Module C (the concept of motion and variables), Module D (one dimensional motion) and Module E (motion in two dimensions). The independent t-test results have given in the Table 3 below.

As seen at Table 3, it was determined that the scores of the arithmetic average of the Module A test achievement was 47.21 and the standard deviation was 13.264 in the RWPG, the scores of the arithmetic average of the Module A test achievement was 34.25 and the standard deviation was 12.588 in the CG. According to the independent t-test results, there was a significant difference between the RWPG and CG ($t = 4.065$; $p < 0.05$). And the scores of the arithmetic average of the Module B test achievement was 61.24 and the standard deviation was 14.046 in the RWPG, the scores of the arithmetic average of the Module B test

Table 3. Results of the independent sample *t* test analysis of multiple-choice questions of all modules

Tests	Groups	N	Mean[a]	*SD*	*t*	p
Modul A	KG	32	34.25	12.588	4.065	0.00
	OYSG	34	47.21	13.264		
Modul B	KG	32	49.53	10.264	3,845	0.00
	OYSG	34	61.24	14.046		
Modul C	KG	32	50.84	12.506	6.257	0.00
	OYSG	34	67.71	9.236		
Modul D	KG	32	49.69	11.058	4.192	0.00
	OYSG	34	61.76	12.267		
Modul E	KG	32	51.22	10.761	5.540	0.00
	OYSG	34	69.91	15.976		

[a]Maximum score= 100.

achievement was 49.53 and the standard deviation was 10.264 in the CG. According to the independent t-test results, there was a significant difference between the RWPG and CG ($t = 3.845$; $p < 0.05$). And the scores of the arithmetic average of the Module C test achievement was 67.71 and the standard deviation was 9.236 in the RWPG, the scores of the arithmetic average of the Module C test achievement was 50.84 and the standard deviation was 12.506 in the CG. According to the independent t-test results, there was a significant difference between the RWPG and CG ($t= 6.257$; $p < 0.05$). And the scores of the arithmetic average of the Module D test achievement was 61.76 and the standard deviation was 12.267 in the RWPG, the scores of the arithmetic average of the Module D test achievement was 49.69 and the standard deviation was 11.058 in the CG. According to the independent t-test results, there was a significant difference between the RWPG and CG ($t = 4.192$; $p < 0.05$). And the scores of the arithmetic average of the Module E test achievement was 69.91 and the standard deviation was 15.976 in the RWPG, the scores of the arithmetic average of the Module E test achievement was 51.22 and the standard deviation was 10.761 in the CG. According to the independent t-test results, there was a significant difference between the RWPG and CG ($t= 5.540$; $p < 0.05$).

The results of content analysis of semi-structured interview to obtain pre-service science teachers' views about reading-writing-presenting technique were analyzed. As a result of the interviews with RWPG, students express that the first time they conducting research and trying to understand and to tell themselves, telling the group who don't understand the topic by working more than their friends to increase the group's success, they are more active than other lessons during the course, their expression skills are increased at the end of the application because of the learner and teacher are themselves, their communication is increased with friends even though they begun to talk the other students that they didn't speak previously, abstain to ask the subject in class that they haven't understood but they can ask friends in group more comfortably, the implementation of this technique would be useful at chemistry and laboratory lessons, provide better work especially in physics subjects, to get a product pleasantly with group in writing phase which is after reading phase, to express themselves better in process of time and to criticize with themselves is efficient, they need to an hour lesson also to solve more questions in physics and sometimes writing report phase is long duration [30-38].

4. Conclusions

In this part, it's focused on the results of reading-writing-presenting technique of cooperative learning model on pre-service science teachers' academic achievements of force and motion subjects in general physics lesson.

When Table 1 is investigated, there is no difference between the two groups for pre-test of AAT, but there is significant difference two groups for the post-test of AAT and this is in favor of RWPG. As seen Table 2 that there is no difference between the two groups for pre-test of GT, but there is significant difference two groups for the post-test of GT and this is in favor of RWPG. It was determined that many students have lacks of especially interpreting the graphs during the study. It is indicated from Demirci and Uyanik's study [9] that before kinematics subject are given to students, give issues related to graphing and interpreting may increase the success of kinematic subjects. In particularly, when teachers use traditional method in science lesson, this leads to students at don't like science lesson. At Table 3, there is significant difference between two groups related to Module tests. As a result of the semi-structured interviews, all groups express that participated actively in class, thanks to a better understanding of the application technique, they contributed to learn as themselves as their friends in groups, their expression skill was increased and communication skill between their friends was increased and the implementation of this technique would be useful in the other lessons [32-38].

In recent years, researches which related to physics showed that teacher-centered method isn't not enough for teaching physics subjects to the students so that, students learn physics superficially [30]. Implementation of active learning instead of teacher-centered instruction provides to students attractiveness actively in lessons and learning on their own and provides to permanent learning. The main purpose of the implementation of these techniques is to provide responsibilities to students, students' own learning and interaction with each other. Listening and learning something from their age group is fun and interesting for students and also motivated them to this sort of learning activities [31-38]. Thus, students share their subjects with other students in different groups, correct their deficiencies all together and learn about different things.

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