# The Effects of Group Investigation and Cooperative Learning Techniques Applied in Teaching Force and Motion Subjects on Students' Academic Achievements

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**ABSTRACT**

The aim of this study is to determine the effect of group investigation and cooperative learning techniques on the academic achievements of first year university students attending classes in which the units of force and motion are taught within the general physics course. The sample of this study consists of 96 first year pre-service science teachers during the 2010-2011 academic year. As data collection instruments, the Academic Achievement Test (AAT), Graphic Test (GT), Module Tests (Module A, B, C, D and E) were used. This study was carried out in three different groups. One of these groups was Group Investigation Group (GIG), the second group was the Learning Together Group (LTG) and the other was the Control Group (CG), in which teacher-centered instruction was applied. The data obtained on instruments were evaluated using ANOVA and descriptive statistics. The results of this study indicated no significant difference between GIG and LTG, but a significant difference between LTG and CG.

*Key Words:* Group Investigation, Learning Together, Force and Motion, Science and Technology

# Kuvvet ve Hareket Konularının Grup Araştırması ve Birlikte Öğrenme Teknikleri ile Uygulanmasının Öğrencilerin Akademik Başarılarına Etkisi

**ÖZET**

Bu araştırmanın amacı, genel fizik dersinin kuvvet ve hareket ünitesi konularının öğrencilere öğretilmesinde grup araştırması ve birlikte öğrenme tekniklerinin öğrencilerin akademik başarılarına etkisini belirlemektir. Çalışmanın örneklemini 2010–2011 öğretim yılı güz döneminde öğrenim gören birinci sınıf Fen ve Teknoloji öğretmen adaylarından oluşan toplam 96 öğrenci oluşturmaktadır. Araştırmada, Akademik Başarı Testi (ABT), Grafik Testi (GT) ve Modül Testleri (Modül A, B, C, D ve E) kullanılmıştır. Çalışma üç farklı grupta gerçekleştirilmiştir. Bu gruplardan; birincisi grup araştırması yönteminin uygulandığı (GAG), ikincisi birlikte öğrenme yönteminin uygulandığı (BÖG) ve üçüncüsü ise öğretmen merkezli yöntemin uygulandığı kontrol grubu (KG) olarak belirlenmiştir. Verilerin analizi için tanımlayıcı istatistikler ve ANOVA kullanılmıştır. Yapılan analizler sonucunda, GAG ve BÖG arasında anlamlı bir farklılığın olmadığı fakat BÖG ile KG arasında anlamlı farklılıkların olduğu belirlenmiştir.

*Anahtar Kelimeler:* Grup araştırması, Birlikte Öğrenme, Kuvvet ve Hareket, Fen ve Teknoloji

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## INTRODUCTION

The main purpose of today's education system is to give students access to available information, and educators must have skills, rather than simply transfer this information to students. Science classes are very important to gain these skills for students. With this perspective, effective science teaching needs to be administered in schools (Kaptan, 1999). Developments in the education system throughout the world have led to the emergence of different approaches and understandings, which presents a variety of perspectives and places the students' learning in the category of constructivism. With this approach, educators attempt to present an active learning process to the students. Active learning is defined as a team model that students take responsibility for self learning in the lesson process (Açıkgöz, 2003; Çelik, Şenocak, Bayrakçeken, Taşkesenligil & Doymuş, 2005).

In science lessons, particularly physics, active learning methods are very important to thoroughly understand. Physics is just one of the science lessons, and is a discipline based on qualitative and quantitative measurements for understanding natural phenomena around us. Students have difficulty learning physics because physics consists of more abstract concepts. Many studies were conducted by researchers about physics, especially force and motion, to better understand them (Beichner, 1990, 1994, 1996; Palmer, 1994; Thornton & Sokoloff, 1998; Candan, Türkmen & Çardak, 2006; Özsevgeç, 2006; Demirci & Uyanık, 2009).

Many studies were conducted to eliminate and resolve the misconceptions about force and motion subjects in physics by researchers (Champagne, Klopfer & Anderson, 1980; Eryılmaz, 2002). Therefore, it is clear that new methods and techniques are needed to provide a much better understanding of force and motion. Cooperative learning is such a method that is an important part of today's education. It has been concluded from a great deal of scientific research related to the cooperative learning method, that it is more effective for student achievement (Doymuş, Şimşek & Bayrakçeken, 2004; Atasoy, Genç, Kadayıfçı & Akkuş, 2007; Kıncal, Ergül & Timur, 2007; Doymuş, 2008; Gök, Doğan, Doymuş & Karaçöp, 2009).

Cooperative learning is a method in which students are assigned to small groups in the classroom, as well as other environments, where the students help each other to learn together. Students achieve more and increase their self-confidence as individuals, develop communication skills and participate actively in this method (Doymuş, Şimşek & Şimşek, 2005). This method is applied with different techniques. The forefronts of these techniques are: Learning Together, Student Teams, Group Investigation, Let's Ask and Learn Together, Jigsaw, and the Reading-Writing-Presentation technique. In this study, the Learning Together and Group Investigation techniques were used.

The Group Investigation (GI) technique was developed by Sharan and Sharan in 1989. In this technique, the class is divided into several groups that study in a different phase of a general issue. The study issue is then divided into working sections among the members of the groups. Students pair up the information, arrangement, analysis, planning and integrate the data with the students in other groups. In this process, the teacher must be the leader of the class and ensure that students comprehend the explanations (Knight & Bohlmeyer, 1990). This technique is suitable in science lessons because it encourages students to learn and attracts them to scientific research (Sherman, 1994).

The Learning Together (LT) technique was developed by Johnson and Johnson in 1989 (Johnson, Johnson & Holubec, 1998). The most important properties of this technique are the existence of the group goal and sharing the opinion and the materials, division of

labour and group reward. Students study together on subjects or work sheets in groups of two to six members. Group members decide together how to study and what to do in accordance with the subjects and assignments. Ultimately, they produce a joint study. Students are rewarded according to achievements in the group and individual studies (Johnson, Johnson & Holubec, 1994; Sharan, 1999; Açıkgöz, 2003).

The purpose of this study is to investigate the effects of Group Investigation, Learning Together and traditional teaching methods on students' understanding of force and motion in an undergraduate physics course.

## METHOD

In analyzing the effects of teaching materials or teaching methods in different schools and classrooms, it is more convenient to use the quasi-experimental research design. A quasi-experimental design was used in this study. In this design, participants are not randomly assigned to the groups; instead, there are naturally occurring groups or groups to which participants are assigned for reasons other than randomizing the sample. The study utilized "a pre-test/post-test non-equivalent comparison group design" (McMillan & Schumacher, 2006).

### Sample

The sample of this study consisted of a total of 96 undergraduates from three different groups enrolled in a general physics course for the 2010–2011 academic year. One of the treatment groups was the Group Investigation Group (GIG) (n=31), the second group was the Learning Together Group (LTG) (n=33) and the other was the Control Group (CG) (n=32). Volunteers were provided with background information regarding the study prior to consent. During the training period, instruction for the treatment groups was delivered by the researchers. Before the beginning of the treatment, the teacher gave information about learning objectives, the instruction process, and rules of working in a cooperative group, roles, and assessment strategies. Groups were randomly selected.

### Instruments

In this study, the Academic Achievement Test (AAT), Graphic Test (GT) and Module Tests (MT) were used. The AAT consists of 20 multiple-choice questions, with each question worth 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 aforementioned force and motion topics 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 ($\alpha$= 0.61). Moreover, to confirm the validity of the AAT that was 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. Two sample questions used on the AAT are available in Appendix A1.

The GT consists of 25 multiple-choice questions and each question worth was four points. The GT was designed to assess the reading and comprehension 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 assessed by an expert 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 aforementioned general physics courses. The KR20 was used for determining the reliability of GT, which was found to be $\alpha$= 0.76. Two sample questions used on the GT are available in Appendix A2.

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. Two sample questions used on the MT are available in Appendix A3.

**Procedure**

In the treatment groups, this study was conducted over a five-week period during which the force and motion unit was as part of the regular curriculum in the general physics course.

**The Group Investigation Implemented**

The GIG students were randomly divided into two parts (Part I, n=16 students + Part II, n=15 students. The students in these parts were divided into five sub-groups as shown in Figure 1, each group thus containing three or four students. The GIG was employed for five weeks to teach the force and motion unit. The main features of the modified group investigation are presented in three phases for each module as given in the (Oh and Shin, 2005), namely 1) in-class discussion, 2) out-of-class investigation, and 3) in-class presentation.

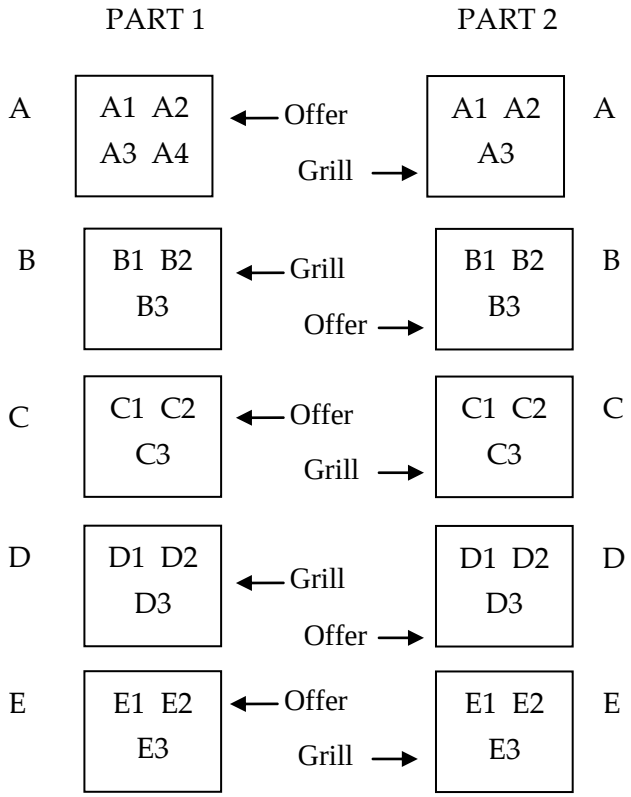

Figure 1. *Forming of grill and offer groups from Parts I and II*

***In-class discussion:*** 1) students are organized into research groups, 2) students get together in their groups for discussion, 3) each group sets an inquiry topic within a given unit and makes a plan for investigation, 4) during the discussion, group members use their science books to identify their own problems, questions, or issues and select a topic of study and 5) the teacher participates in the group discussion and the teacher's roles include encouraging students to select authentic topics that can be addressed in multiple ways.

***In out-of-class investigation*: 1)** each student group carries out its investigation, 2) the teacher helps students with their investigations, 3) the teacher's roles include presenting sources of information, providing instruments for experiments, and assisting students with difficulties and 4) each research group prepares an in-class presentation.

***In-class presentation (Week II)*** Group A in Part 1 was the presentation (offer) group while Group A in Part 2 was the inquiry (grill) group. While Group A in Part 1 presented the topics of Module A, Group A in Part 2 questioned the group about their presentation and determined their weaknesses. Other students in the classroom also participated in the discussion. During Week III, Group B in Part 2 was the offer group while Group B in Part 1 was the grill group. While Group B in Part 2 presented the topics of Module B, Group B in Part 1 questioned the group about their presentation and determined their weaknesses. Other students in the classroom also took part in the discussion. The other grills and offer groups given in Table 1 were organized in the same way as Week II and Week III.

Table 1. *Allocation of weeks and groups of modules*

| Weeks | Grill groups | Offer groups | Modules ( Present topics) |
|---|---|---|---|
| II | Part I A | Part II A | Module A (The concept of force and Newton's laws) |
| III | Part II B | Part I B | Module B (Varieties of force) |
| IV | Part I C | Part II C | Module C (The concept of motion and variables) |
| V | Part II D | Part I D | Module D (One dimensional motion) |
| VI | Part I E | Part II E | Module E (motion in two dimensions) |

**The Learning Together Technique Implemented**

As shown in Figure 2, the cooperative class was divided into seven heterogeneous groups, two groups consisting of four students and five groups consisting of five students. Before the beginning of the instruction, the teacher gave information about learning objectives, the instruction process and rules for working in a cooperative group, group member roles, and assessment strategies (Doymuş & Şimşek, 2007). Students in the groups were encouraged to decide who would be the leader. Later, the heads of the groups were determined by the group members. The subject of related states of matter was presented to the group members by the group heads. Each group studied their subject in and out of the classroom. All activities were completed by students under the guidance of the teacher. While students were discussing in small groups, the teacher visited all the groups and asked guiding questions to lead students in the appropriate direction. The cooperative groups prepared their own reports after the activities were completed. Each group was given 40 minutes to present their work in the classroom and 10 minutes for discussion with the class. During this discussion, the group answered questions from the class. All groups completed their topics in five weeks (Doymuş, Şimşek & Karaçöp, 2009).

Cooperative Groups

| | | | | | | |
|---|---|---|---|---|---|---|
| A1 A2<br>A3<br>A4 A5 | B1 B2<br>B3<br>B4 B5 | C1 C2<br>C3<br>C4 C5 | D1 D2<br>D3<br>D4 D5 | E1 E2<br>E3<br>E4 E5 | F1 F2<br><br>F3 F4 | G1 G2<br><br>G3 G4 |

Figure 2. *The groups in the learning together technique of the cooperative class*

**Implementation of Teacher-centered Teaching Method**

In the control group, the subjects were taught using the teaching-centered method. The researcher planned the presentation activities of the subjects that would be taught during the lesson in a report not with 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 gathering the information to be presented to them. In the traditional learning 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 to the treatment groups by the authors for four hours per week for four weeks. Measurement tools were applied to the treatment groups at the end of the study.

**Data Analysis**

In order to determine the differences among the three treatment groups, a one-way analysis of variance (ANOVA) calculation was made using scores on the AAT, GT and MT.

## FINDINGS

The one-way ANOVA of data obtained from AAT, GT, and MT in the treatment groups are presented in Table 2, 3 and 4 respectively.

Table 2. *One-way ANOVA among treatment groups for scores on the AAT*

| Instruments | | SS | DF | MS | F | P |
|---|---|---|---|---|---|---|
| AAT pre-test | Between Groups | 81.426 | 2 | 40.713 | 0.258 | 0.773 |
| | Within Groups | 14699.563 | 93 | 158.060 | | |
| | Total | 14780.990 | 95 | | | |
| AAT post-test | Between Groups | 1313.810 | 2 | 650.905 | 5.418 | 0.006 |
| | Within Groups | 11276.815 | 93 | 121.256 | | |
| | Total | 12590.625 | 95 | | | |

As seen in Table 2, according to the scores of the AAT pre-test, there was no difference between GIG, LTG and CG [$F_{(2,93)}$=0.258; p>.05]. This finding supports the assumption that the groups should be considered equal. However, according to the scores of the post-test, there was a significant difference between GIG and LTG, CG [$F_{(2\text{-}93)}$=5.418; p<.05].

A Bonferonni test was used to determine which groups differ. According to these results, there was no difference between GIG, LTG and CG, but there was a significant difference between LTG and CG, and this difference was found to be in favor of LTG ($X_{GIG}$ = 55.97; $X_{LTG}$ = 59.39; $X_{CG}$ = 50.47).

To determine the level of students' understanding of force and motion graphics, the GT was used. The one-way ANOVA of data obtained from the GT is below in Table 3.

Table 3. *One-way ANOVA among treatment groups for scores on the GT*

| Instruments | | SS | DF | MS | F | P |
|---|---|---|---|---|---|---|
| GT | Between Groups | 414.550 | 2 | 207.275 | 1.858 | 0.162 |
| Pre-test | Within Groups | 10377.075 | 93 | 111.581 | | |
| | Total | 10791.625 | 95 | | | |
| GT | Between Groups | 1192.995 | 2 | 596.498 | 3.954 | 0.022 |
| post-test | Within Groups | 14028.630 | 93 | 150.845 | | |
| | Total | 15221.625 | 95 | | | |

As seen in Table 3, it was determined that according to the scores of the GT pre-test, there was no difference between GIG, LTG and CG [$F_{(2\text{-}93)}$=1.858; p>.05]. The results of this analysis show that the levels of success in the all groups are closer to each other at the beginning. However, according to the scores of the post-test, there was a significant difference between GIG, LTG and CG [$F_{(2\text{-}93)}$=3.954; p<.05].

A Bonferonni test was used to determine which groups differ. According to these results, there was no difference between GIG and LTG, CG, but there was a significant difference between LTG and CG, and this difference was found to be in favor of LTG ($X_{GIG}$ = 49.29; $X_{LTG}$= 50.48; $X_{CG}$ = 42.50).

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 one-way ANOVA of data obtained from MT is in Table 4 below.

Table 4. *One-way ANOVA among treatment groups for scores on the MT (MA, MB, MC, MD and ME)*

| Instruments | | SS | DF | MS | F | P |
|---|---|---|---|---|---|---|
| Module A | Between Groups | 1260.924 | 2 | 630.462 | 3.602 | 0.031 |
| | Within Groups | 16279.566 | 93 | 175.049 | | |
| | Total | 17540.490 | 95 | | | |
| Module B | Between Groups | 1735.550 | 2 | 867.775 | 4.333 | 0.016 |
| | Within Groups | 18626.450 | 93 | 200.284 | | |
| | Total | 20362.000 | 95 | | | |
| Module C | Between Groups | 2530.105 | 2 | 1265.053 | 6.056 | 0.003 |
| | Within Groups | 19427.634 | 93 | 208.899 | | |
| | Total | 21957.740 | 95 | | | |
| Module D | Between Groups | 3291.697 | 2 | 1645.849 | 5.902 | 0.004 |
| | Within Groups | 25932.928 | 93 | 278.849 | | |
| | Total | 29224.625 | 95 | | | |
| Module E | Between Groups | 1119.218 | 2 | 559.609 | 1.735 | 0.182 |
| | Within Groups | 29989.271 | 93 | 322.465 | | |
| | Total | 31108.490 | 95 | | | |

As seen in Table 4, according to the scores of Module A test, there was a significant difference between GIG, LTG and CG [$F_{(2\text{-}93)}$=3.602; p<.05]. For Module B, there was also a significant difference between GIG, LTG and CG [$F_{(2\text{-}93)}$=4.333 p<.05]. For Module C, there was also a significant difference between GIG, LTG and CG [$F_{(2\text{-}93)}$=6.056; p<.05]. For Module

D, there was also a significant difference between GIG, LTG and CG [$F_{(2-93)}$=5.902; p<.05]. For Module E, there was no difference between GIG, LTG and CG [$F_{(2-93)}$=1.735; p>.05].

Multiple comparisons of the Bonferonni test were used to determine which group was different. According to the Bonferonni test results, there was a significant difference between GIG and CG, and this difference was favor of GIG, but there was no significant difference between GIG and LTG in Module A. For Module B, there was a significant difference between GIG and LTG, and this difference was in favor of GIG, but there was no significant difference between GIG and CG. For Module C, there was a significant difference between GIG and CG, and this difference was in favor of GIG, but there was no significant difference between GIG and LTG. For Module D, there was a significant difference between GIG and CG, and this difference was in favor of GIG, but there was no significant difference between GIG and LTG.

## DISCUSSION AND CONCLUSIONS

This part focuses on the results of the Group Investigation and Learning Together techniques of the cooperative learning model on pre-service science teachers' academic achievements of force and motion subjects in a general physics lesson.

When Table 2 is examined, there is no difference between the groups for the AAT pre-test, but according to the scores of the post-test, there is a significant difference between GIG, LTG and CG. ABonferonni test was used to determine which groups differ. According to these results, there is no difference between GIG and LTG, CG, but there is a significant difference between LTG and CG, and this difference is found to be in favor of LTG. As seen in Table 3, there is no difference between the groups for the GT pre-test of, but there is a significant difference between GIG, LTG and CG for the GT post-test. For this reason, a Bonferonni test was used to determine which groups differ. According to these results, there is no difference between GIG, LTG, and CG, but there is a significant difference between LTG and CG, and this difference is found to be in favor of LTG. When Table 4 is examined, there is a significant difference between all groups for Module A, Module B, Module C and Module D, but there is no difference between groups for Module E. It is determined that many students have particular difficulties in interpreting the graphs during the study. Demirci and Uyanık's (2009) study indicates that before kinematics subjects are given to students, providing issues related to graphing and interpreting may increase the success of kinematic subjects. In particular, when teachers use traditional methods in science lessons, students tend to dislike science.

In recent years, research related to physics showed that the teacher-centered method is not enough for educating students, and therefore, students learn physics superficially (McDermott & Redish 1999). The implementation of active learning instead of teacher-centered instruction actively engages students in lessons and independent learning, and provides permanent learning. The main purpose of the implementation of these techniques is to provide responsibilities to students, their own learning, and interaction with each other. Listening and learning something from their age group is fun and interesting for students, and these types of learning activities also motivated them (Doymuş & Şimşek, 2007). Thus, students share their subjects with other students in different groups, correct their deficiencies together and learn about different things.

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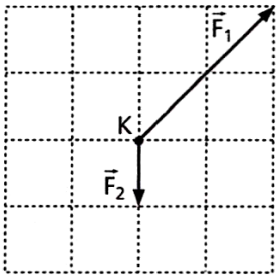
## APPENDIX

**A 1: The questions related to AAT**

**Q1**. Which of the information related to the friction force is wrong?

A) Friction force is opposite direction to motion
B) The size of the friction force depends on the type of the friction surface
C) Friction force increases the speed of the object
D) Friction force is direct proportion with the weight of the object
E) Friction force is an electrostatic event

**Q2.** The force of $F_1$ and $F_2$ applied to the point of K in the horizontal plane and there is no friction force in this place. Then the intensity of $F_2$ increase until twice as uniform without changing the direction. Accordingly to this, what can be said for resultant force about the intensity and direction of movement?

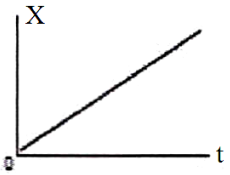



| | intensity of resultant force | direction of movement |
|---|---|---|
| A) | decrease | changeable |
| B) | decrease | unchangeable |
| C) | increase | changeable |
| D) | increase | unchangeable |
| E) | unchangeable | changeable |

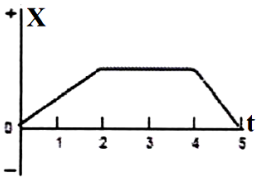
**A 2: The questions related to GT**

**Q1.**To the right is a graph of an object's motion. Which sentence is the best interpretation?

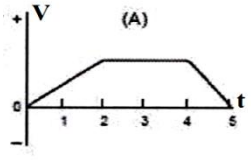
A) The object is moving with a constant acceleration
B) The object does not move
C) The object is moving with a uniformly increasing velocity
D) The object is moving at a constant velocity
E) The object is moving with an increasing acceleration

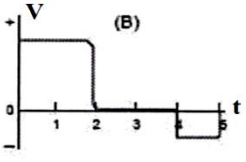


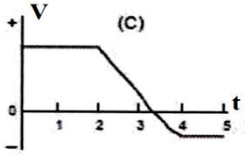

**Q2.** The position-time graph of an object's motion is given below.

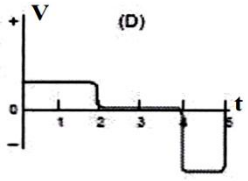


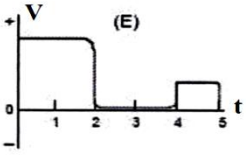

Which one of the following graphs of velocity versus time would best represent the object's motion during the same time interval?



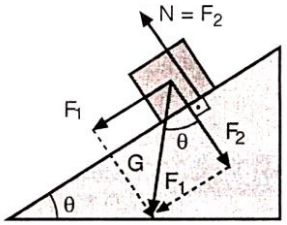



**A3: The question related to MT**

**Q1. (Module A)**

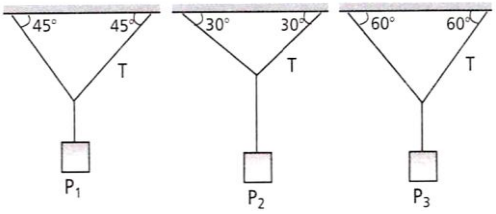
a) Examine the mass of m object's motion on the incline ramp at the right figure.

b) Which conditions can be said if there is no force acting on an object? Explain.




**Q1. (Module B)**

$P_1$, $P_2$ and $P_3$ weighted objects are balanced with rapes as shown in the right figure. In all three cases, tensile forces are equal at the rope so, what is the relationship between $P_1$, $P_2$ and $P_3$?




A) $P_1 < P_2 < P_3$ B) $P_3 < P_1 < P_2$ C) $P_1 < P_3 < P_2$
D) $P_2 < P_3 < P_1$ E) $P_2 < P_1 < P_3$

**Q1. (Module C)**

If the time is equal of the two vehicle's motion that will replace on equal amount,

I. Accelerations
II. Average velocities
III. Instantaneous velocities

which quantities are exactly the same?

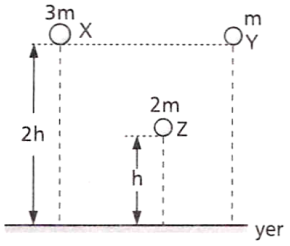
A) I only B) II only C) III only D) I and II E) II and III

**Q1. (Module D)**

a) Respectively, the masses of 3m, m and 2m objects are released as shown in the figure. As far as the friction of air is neglected, what is the relationship between $t_x$, $t_y$ and $t_z$ that is the time of falling down?

b) What can be said about the times of falling down a feather and a spall in an airless tube with free fall? Explain.

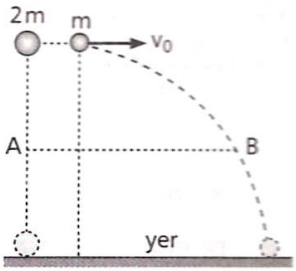
c) To draw the back direction of regular accelerating movements' graphs of x-t, v-t, a-t.




**Q1. (Module E)**

For the motion of released mass of 2m object and thrown horizontally mass of m object in airless area so, which sentence is true?

I. Flight times are equal
II. Income on the level of AB equally
III. Hit the ground velocities are equal




A) I only B) I and II C) I and III
D) II and III E) I, II and III

# Kuvvet ve Hareket Konularının Grup Araştırması ve Birlikte Öğrenme Teknikleri ile Uygulanmasının Öğrencilerin Akademik Başarılarına Etkisi

Nilüfer OKUR AKÇAY[3], Kemal DOYMUŞ[4]

**Giriş**

Günümüz eğitim sisteminin temel amacı, öğrencilere mevcut bilgileri aktarmaktan çok onların bu bilgilere erişebilmelerini gerektirecek beceriler kazandırmaktır. Öğrencilerin bu becerileri kazanmalarında fen dersleri oldukça önemlidir. Eğitim sistemimizde yaşanan gelişmeler farklı yaklaşımları ortaya çıkarmıştır. Bunlardan biri de yapılandırmacılık yaklaşımıdır. Bu yaklaşım ile öğrencilerin öğrenme sürecinde aktif olması sağlanmaktadır. Fen derslerinde, özellikle de fizik eğitiminde aktif öğrenme metotları, konuların daha iyi anlaşılmasında oldukça önemlidir. Fizik, daha çok soyut kavramlardan oluşan, bu nedenle de öğrencilerin öğrenirken çok zorluk yaşadığı ve çevremizdeki doğa olaylarının birçoğunu anlayabilmek için nitel ve nicel ölçümlere dayanan bir bilim dalıdır (Beichner, 1990, 1994, 1996; Palmer, 1994; Thornton & Sokoloff, 1998; Candan, Türkmen & Çardak, 2006; Özsevgeç, 2006; Demirci & Uyanık, 2009).

Öğrencilerin soyut kavramların yoğunlukta olduğu fizik dersinin konularını özellikle kuvvet ve hareket konusunu daha iyi anlamalarını sağlamak amacıyla yeni yöntem veya tekniklere ihtiyaç duyulduğu açıktır. Bu yöntemlerden biri de günümüz eğitim sisteminde önemli yere sahip olan işbirlikli öğrenme yöntemidir. İşbirlikli öğrenme; öğrencilerin hem sınıf hem de diğer ortamlarda küçük karma gruplar oluşturarak ortak bir amaç doğrultusunda akademik bir konuda birbirlerinin öğrenmelerine yardımcı oldukları, bireylerin özgüvenlerinin arttığı, iletişim becerilerinin geliştiği, öğrencinin en aktif şekilde katıldığı bir öğrenme yöntemidir (Doymuş, Şimşek & Şimşek, 2005). İşbirlikli öğrenme modelinde farklı teknikler kullanılır. Bu tekniklerden önde gelenleri şunlardır; Birlikte Öğrenme Tekniği, Öğrenci Takımları Tekniği, Grup Araştırması Tekniği, Birlikte Soralım Birlikte Öğrenelim Tekniği, Jigsaw Tekniği ve Okuma-Yazma-Sunma Tekniği. Bu araştırmada işbirlikli öğrenme tekniklerinden olan grup araştırması, birlikte öğrenme tekniklerinden bahsedilmektedir.

Grup Araştırması tekniği Sharan ve Sharan (1989) tarafından geliştirilmiştir. Grup Araştırması tekniğinde, ilk olarak sınıf her biri genel bir konunun farklı bir safhasını çalıştığı birkaç gruba ayrılır, daha sonra çalışma konusu grup üyeleri arasında karşılıklı dayanışmayı sağlayan çalışma bölümlerine ayrılır. Öğrencilerin bilgileri bir araya getirmeleri, düzenlemeleri, analiz yapmaları, planlamaları ve diğer grup öğrencilerinin çalışmalarıyla bütünleştirmeleri sağlanır. Öğretmenin bu aşamadaki rolü ise, öğrencilerin araştırmalarını yapabilmeleri ve bilgilerini paylaşabilecekleri ortamları sağlamaktır. Bu teknik, fen derslerinde öğrencileri bilimsel araştırmalara katmak ve öğrencileri öğrenmeye cesaretlendirmek için uygundur.

Birlikte öğrenme tekniği Johnson ve Johnson (Johnson vd. 1998) tarafından geliştirilmiştir. Birlikte öğrenme tekniğinde, ilk olarak amaçlar belirlenir ve amaca yönelik

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gruplar oluşturulur. Öğrenciler iki ya da altı kişilik gruplarda kendilerine verilen çalışma konuları ya da çalışma yaprakları üzerinde birlikte çalışırlar. Grup üyeleri, grup konularının ve ödevinin amaçları doğrultusunda ne yapacaklarını ve nasıl çalışacaklarını birlikte kararlaştırırlar. Daha sonra öğrenciler araştırdıkları konuyu rapor haline getirirler ve grup arkadaşlarına sunumlar yaparlar. Sonuçta ortak bir çalışma ortaya koyarlar. Öğrenciler, grup içindeki başarılarına ve bireysel çalışmalarına göre ödüllendirilirler.

Bu araştırmanın amacı, genel fizik dersinin kuvvet ve hareket ünitesi konularının öğrencilere öğretilmesinde grup araştırması tekniği, birlikte öğrenme tekniği ve öğretmen merkezli öğretim yönteminin Fen ve Teknoloji öğretmen adaylarının akademik başarılarına etkisini belirlemektir.

**Yöntem**

Bu araştırma, rastgele (random) seçilmiş gruplarda ön test-son test deney ve kontrol gruplu yarı deneysel araştırma (quasi-experimental designs) modelindedir. Çalışmanın örneklemini, 2010-2011 öğretim yılının güz döneminde Ağrı İbrahim Çeçen Üniversitesi Eğitim Fakültesi Fen ve Teknoloji öğretmenliği bölümünde öğrenim gören ve Genel Fizik-I dersini alan toplam 96 öğretmen adayı oluşturmaktadır. Rastgele olarak belirlenen öğretmen adaylarından oluşan üç farklı grup oluşturulmuştur. Bunlar; Grup Araştırması Grubu (GAG, n=31), Birlikte Öğrenme Grubu (BÖG, n=33) ve Kontrol Grubu (KG, n=32) şeklinde belirlenmiştir. Çalışmada, Akademik Başarı Testi (ABT), Grafik Testi (GT), Modül testleri (Modül A, B, C, D ve E) kullanılmıştır. Araştırma grupları arasındaki farklılıkları belirleyebilmek için tek yönlü varyans analizi (ANOVA) yapılmıştır.

**Bulgular**

Araştırma kapsamında yürütülen yöntem ve tekniklerin kuvvet ve hareket konusundaki akademik başarıya etkisini belirlemek için GAG, BÖG ve KG 'ye uygulanan ABT ön test puanları arasında ANOVA sonuçlarına göre fark bulunmamıştır [$F_{(2,93)}$=0.258; p>.05]. Fakat ABT son test puanları arasında farklılıklar bulunmuştur [$F_{(2,93)}$=5.418; p<.05]. Bu farklılıkların hangi grup lehine olduğunu belirleyebilmek için Bonferonni testi uygulanmış ve Bonferroni analizi sonucuna göre, GAG ile BÖG ve KG arasında akademik başarı puanları açısından bir farkın olmadığı fakat BÖG ile KG arasında anlamlı bir farkın olduğu ve bu farkın BÖG lehinde olduğu tespit edilmektedir ($X_{GAG}$ = 55.97; $X_{BÖG}$= 59.39; $X_{KG}$ = 50.47).

GT ön testi akademik başarı puanları arasında, ANOVA analizi sonuçlarına göre, gruplar arasında farklılık görülmemiştir [$F_{(2,93)}$=1.858; p>.05]. Fakat GT son testi akademik başarı puanları arasında anlamlı farklılık görülmektedir [$F_{(2,93)}$=3.954; p<.05]. Bu farklılıkların hangi grup lehine olduğunu belirleyebilmek için Bonferonni testi uygulanmış ve Bonferroni analizi sonucuna göre, GAG ile BÖG ve KG arasında bir farkın olmadığı fakat BÖG ile KG arasında anlamlı bir fark olduğu ve bu farkın BÖG lehinde olduğu tespit edilmektedir ($X_{GAG}$ = 49.29; $X_{BÖG}$= 50.48; $X_{KG}$ = 42.50).

Kuvvet ve hareket konusunun her bir alt başlığı için hazırlanan modül testlerinin etkisini belirlemek için GAG, BÖG ve KG 'ye uygulanan Modül A (kuvvet kavramı ve Newton'un yasaları), Modül B (kuvvet çeşitleri), Modül C (hareket kavramı ve değişkenleri), Modül D (bir boyutta hareket) ve Modül E (iki boyutta hareket) testlerine ait puanlara ilişkin ANOVA sonuçlarına göre, araştırma gruplarının modül A [$F_{(2,93)}$=3.602; p<.05], modül B [$F_{(2,93)}$=4.333 p<.05], modül C [$F_{(2,93)}$=6.056; p<.05] ve modül D [$F_{(2,93)}$=5.902; p<.05] puanları arasında anlamlı farklılığın olduğu fakat modül E [$F_{(2,93)}$=1.735; p>.05] puanları arasında

anlamlı bir farkın olmadığı görülmektedir. Farklılığın hangi grup lehine olduğunu belirlemek amacıyla Bonferonni çoklu karşılaştırma testi yapılmıştır. Bonferonni testi sonuçlarına göre; GAG'nin modül A ortalama puanlarının KG'den anlamlı düzeyde farklı olduğu ve bu farkın GAG lehinde olduğu fakat GAG ve BÖG'nin modül A puanları arasındaki farkın anlamlı olmadığı görülmüştür. GAG'nin modül B ortalama puanlarının BÖG'den anlamlı düzeyde farklı olduğu ve bu farkın GAG lehinde olduğu fakat GAG ve KG'nin modül B puanları arasındaki farkların anlamlı olmadığı tespit edilmiştir. GAG'nin modül C ortalama puanlarının KG'den anlamlı düzeyde farklı olduğu ve bu farkın GAG lehinde olduğu ancak GAG ve BÖG'nin modül C puanları arasındaki farkın anlamlı olmadığı tespit edilmiştir. GAG'nin modül D ortalama puanlarının KG'den anlamlı düzeyde farklı olduğu ve bu farkın GAG lehinde olduğu, GAG ve BÖG'nin Modül D puanları arasındaki farkların anlamlı olmadığı görülmüştür.

**Tartışma ve Sonuç**

Son yıllarda yapılan çalışmalar fizik eğitiminde öğretmen merkezli öğretimin yetersiz kaldığını ortaya koymuştur. Bu nedenle öğrenciler fiziği yüzeysel bir şekilde öğrenmektedirler. Öğretmen merkezli öğretim yönteminin yerine aktif öğrenme tekniklerinin uygulanmasındaki temel amaç; ders esnasında öğrencilerin birbirleri ile olan etkileşimlerini sağlama ve öğrencilerin kendi öğrenmelerinde onlara sorumluluk verebilmektir. Kendi yaş grubundan bir şeyler dinlemek ve öğrenmek öğrenciler için daha zevkli ve ilgi çekici olmakta, aynı zamanda onları bu tür öğrenme faaliyetlerine motive etmektedir. Böylece öğrencilerin kendi konularını başka gruplardaki öğrencilerle paylaşmakla birlikte eksikliklerini gidermelerine ve farklı şeyleri öğrenmelerine olanak sağlanmış olur.

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