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The Effects of Peer Instruction Method on Attitudes of 9th Grade Students towards Physics Course

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Abstract
The aim of this study is to determine the effects of peer instruction method on student attitudes towards physics course. In the study, single group pre and posttest quasi- experimental design was adopted. The study was conducted with 46 students registered to 9th grade in a secondary school situated in Ankara province in Turkey in the spring term of 2012-2013 educational year. During 50 class hours "Force and Motion" and "Energy" units were instructed with peer instruction method. "Physics Attitude Scale (PAS)" was utilized as the main data collection tool of the study. PAS is 5-choice Likert type scale with 30 items. The reliability coefficient Cronbach Alpha of the PAS was calculated as 0.963. PAS which, was applied onto the students before and after peer instruction period has 4 factors called; 'physics course perception', 'appreciating the value of physics course', 'expectations about physics course' and 'hesitations about physics course'. The data obtained with PAS were analyzed with dependent samples t-test. There was statistically significant difference between 'appreciating the value of physics course' and 'expectations about physics course' factors. This difference may arise from that the peer instruction method encourages students to speak and share ideas among peers more frequently about physics phenomena. As a result of the study the application of peer instruction method was recommended as it facilitates conceptual discussions in abstract concepts of physics.

Keywords: Peer Instruction, Attitude Towards Physics, Physics Education

Introduction

One of the main principals of the new physics curriculum, first implemented in 2013-2014, is improving scientific literacy. The curriculum not only does validate student improvement in cognitive domain, but also concerns student improvement in affective and psychomotor domains among its primary objectives (MoNE, 2013). It is known that affective elements are generally neglected in instructional process. Kroh and Thomsen (2005) argue that instructional methods should mind not only cognitive parameters but also affective parameters linked to attitude. Most of the previous studies indicated a positive correlation between affective features and student achievement (Abak, 2003; Schibeci & Riley, 1986; Shringley, Koballa & Simpson, 1988; Simpson & Oliver, 1990; Ugurluoglu & Walberg, 1979). Koballa (1988) perceives affective elements as significant as cognitive elements as they also affect career decisions.

Since the concept of affective features is a complex concept, the related studies mainly focused on particular affective characteristics and investigated their effects. These studies mainly focused motivation, interest, importance, self-sufficiency and anxiety (Duit, Niedderer

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& Schecker, 2007; Gencel, 2006; Germann, 1988; Jacobowitz, 1983; Jones, Howe & Rua, 2000; Peşman, 2012; Weingburg, 1995). The trends in PER is on student attitudes towards physics course (Bennet, Lubben & Hogarth, 2007; Keskin, 2008; Peşman, 2012).

Certain studies investigating the relation between achievement and attitude by means of attitude scales indicated positive correlation between them (Abak, 2003; Duit et al., 2007; Oliva, 2003; Oliver & Simpson, 1988; Schibeci & Riley, 1986). These studies indicated that students generally show positive attitude towards courses that they are successful. Duit, Niedderer & Schecker (2007) indicates that the attitude of the student plays a significant role during learning science. Consequently student attitude should be improved in positive way so that they can reach intended achievement level in physics course.

It is a popular research area to investigate the effects of different instructional methods on student attitudes towards the physics course. While there were some studies implying that constructivist learning theory based instructional activities positively affect student attitudes (Hırça, Çalık & Seven, 2011). Still there were some other studies stated that these activities have no effect (Keskin, 2008; Kocakaya & Gönen, 2010; Nuhoğlu & Yalçın, 2006; Peşman, 2012). Peşman (2012) explained ineffectiveness of the applied instructional method with short application period (only for one course unit time) and its not being adapted to school program holistically. On the other hand, studies with conceptual change texts (Yılmaz, 2010), problem solving strategy (Erdemir, 2009), and graphical representations (Erdemir & Topcu, 2012) determined positive influence on attitude towards physics. Erdemir and Topcu (2012) noted that future plans of pre-service teachers for using graphical representations can cause developing positive attitude towards physics.

The present study investigated whether peer instruction has effect on student attitudes. The Turkish domestic literature review revealed that there was positive influence in attitudes of students instructed with peer instruction but there were no significant differences in groups instructed with traditional method (Şekercioğlu, 2011; Tokgöz, 2007). Crouch and Mazur (2001) detected a negligible difference in the attitudes of the students instructed with peer instruction through a full school term. The applied questionnaire showed that the student self-trust and satisfaction about the course increased. The increase in the self-trust can be explained by their discussion with group partners, which helps them to reach the answer. Besides, student satisfaction referred as an important factor in terms of achievement (Crouch & Mazur, 2001).

Peer instruction

Peer instruction can be defined as a method where students are actively engaged into educational process by discussing within a peer group and by helping each other among the group (Crouch & Mazur, 2001; Mazur, 1997; Nicol & Boyle, 2003). The method is a way of keeping students active in abstract topics with descriptive nature.

Peer instruction method is applied by following preparation, instruction and evaluation stages (Crouch & Mazur, 2001; Gök, 2012; Miller, Santana-Vega & Terrell, 2006). In the preparation stage the teacher prepares a test with questions making students focus on the single concept of concern and directing them metacognitive thinking. The preparation of the test needs a considerable effort (Fagen, Crouch & Mazur, 2002). The better prepared multiple choice questions make peer discussions more effective and improve learning (Crouch & Mazur, 2001). Students should complete reading the topic before the class-hour so that more time could be saved for discussing these questions.

In the instruction stage the teacher summarizes the topic and then asks students previously prepared conceptual questions. Students consider about the questions by

themselves and they present their thoughts to the teacher by writing on flashcards or raising their hands (Crouch & Mazur, 2001). Afterwards the teacher makes students put forward proves to persuade their friends about his/her answer. During this stage the, teacher listens student dialogues within the group starting with "what do you think?" and "why do you think in that way?" and going on with responses like "I am not so sure but I think …" (Miller et al., 2006). Nicol and Boyle (2003) assert that students' discussions with each other provides opportunity for deeper thinking about the problem, discovering alternative ideas and problem solving approaches, demanding and encountering different explanations. Then, the teacher closes the discussion and re-votes the student answers. Therefore the teacher can decide whether the intended knowledge is corrected, constructed or altered (Suppapittayaporn, Emarat & Arayathanitkul, 2010). Finally the teacher passes through the next topic after explaining the correct answers. In the evaluation stage students are not given grades for the answers in the concept test. However since school examinations would be in parallel nature, students are supposed to gain a strong sense of dealing with such questions (Crouch & Mazur, 2001).

Limited number of studies related to 'peer instruction' in Turkish national literature focuses the effect of the method on conceptual achievement and attitude (Şekercioğlu, 2011; Tokgöz, 2007). A quasi-experimental design with pre and post-test and control group was adopted for all the mentioned studies. The sample students proved more successful in the physics topics when the peer instruction method was compared to the traditional method. However there was no significant difference between the attitude scores towards physics for the experimental and control groups. The international literature particularly concentrates on the effect of peer instruction on student achievement (Lasry, Mazur & Watkins, 2008; Suppapittayaporn et al., 2010). Crouch and Mazur (2001) tried to determine the effect of peer instruction on student achievement in General Physics II course in a ten year period in Harvard University. It was concluded that peer instruction positively influenced the student achievement in physics course compared to the traditional method.

Attitude towards physics is one of the most prominent factors affecting physics achievement of students. Therefore, determining instructional methods improving physics attitudes of students is important. It is necessary to determine the effect of peer instruction method, which is proved as an effective method to teach abstract topics of physics, on student attitudes towards physics. Previous studies with peer instruction were applied in crowded university classrooms, only with multiple choice concept questions and only its effects on student achievement were investigated. This study is of significance with respect to investigating the effects of the peer instruction method on the attitudes of high school students towards physics by the application of concept cartoons and worksheets as well as conceptual questions. In addition, this study is also expected to contribute to scientific literature by studying the peer instruction method onto student attitudes towards physics with related sub factors as: physics course perception, appreciating the value of physics course, expectations about physics course, and hesitations about physics course.

Purpose of the study

The aim of this study is to investigate the effects of peer instruction method on student attitudes towards the physics course.

Research questions

1. Is there any difference between the pre-and post-test mean scores of Physics Attitude Scale (PAS)?

2. Is there any difference between female and male students in the pre-test scores of the students?

3. Is there any difference between female and male students in the post-test scores of the students?

4. Is there any difference between "students who know" and "students who know less" in the pre-test scores of the students?

5. Is there any difference between "students who know" and "students who know less" in the post-test scores of the students?

Methodology

A single group, pre/post-test research method was adopted for this study. In such studies, it is possible to test and confirm some parameters and effects with the help of the statistical methods (Kaptan, 1998; Nasiriyan et al., 2011; Tekiroğlu Doğan, 2005).

Study group

The study group was 46 students registered to two 9th grade classrooms of a secondary school situated in Ankara in the spring term of 2012-2013 educational year. The practitioner teacher works for the sample school and was the physics course teacher of the related classrooms.

Data collecting tool and analysis

"Physics Attitude Scale (PAS)" was used as the data collecting tool of the study (Kocakülah & Kocakülah, 2006). This 5-choice Likert type scale has 30 items. Student score range for the scale can be between 30 and 150. The reliability coefficient of the scale Cronbach Alpha was calculated as 0.963. PAS, which was applied before and after the application of peer instruction, had 4 factors as: 'physics course perception', 'appreciating the value of physics course', 'expectations about physics course' and 'hesitations about physics course'. The reliability coefficients for these factors were also calculated in terms of Cronbach Alpha as; 0,983 for physics course perception; 0,913 appreciating the value of physics course; 0,852 for expectations about physics course and 0,816 for hesitations about physics course. These values stated that the scale was suitable to be applied to the study group. The negative expressions in the scale were reversed into positive ones during the data were being recorded. The obtained results were interpreted accordingly.

The data obtained from PAS were analyzed with t-test for dependent samples analysis. In addition, "Cohen's d" value was calculated, in order to determine educational significance of the divergence appeared in the post test. "Cohen's d" value is one of the methods for calculating the effect size when average scores of groups are compared (Thalheimer & Cook, 2002). The effect size of 0,20 value is referred as small, 0,50 is referred as medium and 0,80 is accepted as high (Cohen, 1992).

The application of Peer Instruction

The application carried out in two stages as pre instruction and in instructional phases. In the pre-instruction stage a new classroom order was made. For this purpose 3 units before the application were covered with conventional methods. The students were objected to achievement tests at the end of the each unit. The students were divided into two groups as 'the ones who know' and 'the ones who know less' with regard to average scores out of these tests. Then the students were informed about the peer instruction method. Then the students were made to sit in the groups of two. The students with higher test scores (the ones who know) were matched with the students with lower test scores (the ones who know less) on

voluntary basis and 23 groups was formed. After arranging the classroom order, 'Force and Motion' and 'Energy' units were instructed with peer instruction method. The application of peer instruction method took 50 classroom hours. The instructional phase of the application of the peer instruction method was conducted in three steps as follows.

Presentation of the lesson: In this stage teacher summarizes the lesson. She/he answers the student questions and solves a couple of sample questions.

Discussion about questions: In this stage the teacher provides students with different activities like conceptual questions, concept cartoons, worksheets, analysis of daily life events, and problems etc. about the topic. She/he first expects all students to examine the activity and then volunteer students to explain the solution to their partners and persuade them. Each group is given a certain time depending on the type of activity. During this limited time the teacher does not interrupt the groups. She/he listens to their work by walking along the classroom and gets to know about the student ideas about the concept.

Explanation of the correct responses: After students complete the activities, the opinions of the groups are asked about the correct answers. If more than 50% of the groups give the correct answer, the teacher chooses one of the volunteer groups to explain the answer with reasons. If the correct answer ratio is low then the teacher explains the answer.

Findings

In this section the analysis data coming from PAS were presented in the form of the tables. Since the data showed normal distribution, dependent samples t-test was applied. It was investigated whether there was a difference between scores of pre and post PAS and its factors. The obtained data were summarized in Table 1.

Table 1. The results of dependent samples t-test scores of the group for PAS

Factors	N	X	Standard deviation	df	t	p	Cohen's d
Physics course perception							
Pre-test	46	31	9.9	45	0.86	0.39	0.21
Post-test	46	29	9.4				
Appreciating the value of physics course	46	21	7.9	45	1.95	0.03	0.66
Pre-test	46	26	7.4				
Post-test							
Expectations about physics course							
Pre-test	46	17	5.5	45	2.08	0.04	0.37
Post-test	46	19	5.4				
Hesitations about physics course							
Pre-test	46	18	4.74	45	1.85	0.07	0.20
Post-test	46	17	4.99				
Total							
Pre-test	46	81	7.9	45	0.69	0.48	0.25
Post-test	46	83	8.3				

As seen in Table 1, there were significant differences between pre-test and post-test scores for "Appreciating the value of physics course" and "Expectations about physics course" factors ($p<.05$). The difference favors the post-test. It was observed that the effect size was at medium level for "Appreciating the value of physics course" factor but small for "Expectations about physics course" factor. However, there were no significant differences

between pre and post test scores of "Physics course perception" and "Hesitations about physics course" (p>.05).

Over the pretest scores of the students from the scale, the relation between attitude scores with respect to gender parameter was investigated with independent samples t-test and the results were presented in Table 2.

Table 2. Independent samples t-test results attitude scale pretest scores with respect to gender

Factors	Group	N	X	Standard deviation	Degree of freedom	t	Significance (p)
Physics course perception	Female	24	29	9.7	44	.11	.91
	Male	22	30	9.4			
Appreciating the value of physics course	Female	24	22	7.2	44	.64	.52
	Male	22	21	7.7			
Expectations about physics course	Female	24	17	5.6	44	.26	.79
	Male	22	17	5.5			
Hesitations about physics course	Female	24	16	5.1	44	.13	.89
	Male	22	16	4.9			
Total	Female	24	81	8.4	44	.03	.52
	Male	22	82	7.4			

As seen in Table 2, there was no significant difference between female students and male students in the pretest attitude scores of students (p>.05). The comparison of the male and female students' posttest scores was given in Table 3.

Table 3. Independent samples t-test results attitude scale posttest scores with respect to gender

Factors	Group	N	X	Standard deviation	Degree of freedom	t	Significance (p)	Cohen's d
Physics course perception	Female	24	29	10.8	44	.17	.10	0.54
	Male	22	34	8.3				
Appreciating the value of physics course	Female	24	23	8.4	44	.79	.43	0.26
	Male	22	25	7.4				
Expectations about physics course	Female	24	18	5.5	44	2.0	.04	0.60
	Male	22	21	4.8		3		
Hesitations about physics course	Female	24	17	5.4	44	2.2	.03	0.70
	Male	22	20	3.2		5		
Total	Female	24	83	7.9	44	0.6	.25	0.12
	Male	22	82	8.8		5		

As seen in Table 3, there was no significant difference over the posttest scores of the female and male students for "Physics course perception" and "Appreciating the value of physics course" (p>.05). On the other hand there was a significant difference between male and female student posttest scores for "Expectations about physics course" and "Hesitations about physics course" factors favoring the male students (p<.05). It was observed that effect size for both factors were medium level with respect to Cohen d value.

The pretest scores of 'students who know' and 'students who know less' were compared with independent samples t-test and the results were presented in Table 4.

Table 4. Independent samples t-test results for pretest scores of 'students who know' and 'students who know less'

Factors	Group	N	X	Standard deviation	Degree of freedom	t	Significance (p)
Physics course perception	Know	23	31	11.3	44	.93	.36
	Know less	23	29	7.6			
Appreciating the value of physics course	Know	23	23	9.2	44	.88	.38
	Know less	23	21	5.5			
Expectations about physics course	Know	23	18	7.1	44	.88	.39
	Know less	23	17	3.8			
Hesitations about physics course	Know	23	17	5.6	44	.57	.58
	Know less	23	16	4.5			
Total	Know	23	80	1.7	44	.56	.56
	Know less	23	82	1.7			

As seen in Table 4, there was no significant difference between pretest scores of "students who know" and "students who know less" ($p>.05$). The relation between posttest scores of the same students was presented in Table 5.

Table 5. Independent samples t-test results for posttest scores of 'students who know' and 'students who know less'

Factors	Group	N	X	Standard deviation	Degree of freedom	t	Significance (p)	Cohen's d
Physics course perception	Know	23	35	8.8	44	2.48	.01	0.77
	Know less	23	28	9.7				
Appreciating the value of physics course	Know	23	27	8.4	44	2.19	.03	0.66
	Know less	23	22	6.9				
Expectations about physics course	Know	23	22	4.3	44	2.28	.02	0.81
	Know less	23	18	5.7				
Hesitations about physics course	Know	23	20	3.9	44	2.5	.01	0.93
	Know less	23	16	4.8				
Total	Know	23	82	10.6	44	0.29	.07	0.11
	Know less	23	83	6.05				

As seen in Table 5, there were significant differences between posttest scores of the students who know and the students who know less for all factors and for the whole scale ($p<.05$). All these differences favor the students who know. Based on Cohen's d values; the effect size for "Physics course perceptions" and "Appreciating the value of physics course" factors were at medium level but for "Expectations about physics course" and "Hesitations about physics course" factors they were high.

Conclusions and Suggestions

The results indicating higher posttest scores for "Appreciating the value of physics course" and "Expectations about physics course" factors might result from students' talk and sharing ideas to make correct decisions about physical phenomena in the peer instruction method. Starting from this point, it can be understood that students' having opportunity to receive help from their peer and to discuss with them about the topics they have difficulty to understand make them more comfortable with physics topics, positively affect their related senses positively, reduces worries and increases their self-trust.

It was determined that peer instruction had no statistically significant effect over scores of "Physics course perception" and "Hesitations about physics course" factors and the overall scale. Şekercioğlu (2011) and Tokgöz (2007) also reported that peer instruction has no significant effect on student attitudes towards physics. This result might be brought about the cognitive inconsistencies the students experienced during the discussions about concept cartoons and conceptual questions. It is known that concept cartoons are an effective means to create cognitive imbalance. In this context, the reason for students' perceiving the physics as a difficult course may be the result of the effort they shed to overcome the mental imbalances they experienced.

The gender comparisons through the study yielded statistically significant difference only in two factors favoring the male students. Several studies stated that male students bear more positive attitudes towards the physics course than female students (Abak, 2003; Jone et al., 2000; Mattern & Schau, 2002; Simpson & Oliver, 1990). Moreover, Peşman (2012) reported that neither conceptual approach nor learning cycle application could equalize attitude and motivation state of males and females.

Lasry et al. (2008) reported that in their study peer instruction increased the achievement scores of students both in "knowing" and "knowing less" groups. However in the present study peer instruction only increased the attitude scores of students in "knowing" group. Those students who were successful in physics developed positive attitudes towards physics might be the result of their perception that they learnt better when they taught students "knowing less".

Suggestions made based upon the results of the study:

This study investigated the effect of peer instruction on student attitude towards physics. Further studies may also examine the correlation between student achievement and attitude. This may reveal both the effects of peer instruction on student achievement and the relation between achievement and attitude.

Peer instruction should provide opportunity to explain the topic and to help group mates to solve the problem for not only "knowing" students but also students "knowing less". The results implied that female students need more encouragement. We think that this will help improving their attitudes.

Application of a single tool to state attitude restricted the data of the present study to quantitative data. Observation over the peer instruction process and interviews with students may provide more detailed description of student interaction and their pursuit of correct answer.

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