Instruction of learning strategies: Effects on conceptual learning, and learning satisfactions

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Contents

Abstract

This study has investigated the effects of learning strategy instruction on conceptual learning, and student satisfactions in an introductory physics course at university level. In this study, pretest-posttest and quasi-experimental design with a non-equivalent control group was used. A total of 36 sophomore students majoring in mathematics teaching in a four-year pre-service primary teacher education program in Turkey participated. There was one control group and one experimental group; namely, the summarizing group. The summarizing group (n=18) received physics instruction with summarizing strategy instruction and the control group (n=18) received physics instruction in line with traditional teaching methods. Data were collected via the pre and post administration of the Conceptual Learning Open-Ended Test (CLOET), and the Student Satisfaction Scale (SSS). The results indicated that summarizing strategy instruction has positive effects on conceptual learning. However, it has been observed that "strategy teaching" has no significant effect on students' satisfaction in the participation in physics courses. The paper ends with some implications for the instruction of physics.

Keywords: summarizing, strategy instruction, physics, conceptual learning, learning satisfaction

Introduction

Two of the significant objectives of the introductory physics course are to teach students fundamental concepts and principles, and help them apply their knowledge successfully when problem solving (Leonard, Dufresne & Mestre, 1996). In addition, research on the teaching and learning of physics revealed that the traditional lecture where students are passive learners does not substantially impact students' learning and understanding of the most basic physics concepts (Desbien et al., 2005). On the other hand, the constructivist view on learning, which has been recently developed, has been said to enhance innovation in science as well as university physics teaching (Chang, 2005). In this context, to promote learning and teaching in physics, various instructional interventions were suggested. One of them is strategy-based instruction. This paper focuses on one type of strategy-based instruction, namely learning strategy. As Weinstein and Mayer have put it, whereas some psychologists label problem-solving strategies as **cognitive** or **learning strategies**, some others name them as **metacognitive** or **self-regulation strategies** (Morse & Morse, 1995). So, in this study, problem-solving strategies, a matter of crucial importance in physics learning, have been considered within learning strategies. Although the study of learning strategies is not a new subject in physics, this research paper will definitely contribute to existing literature on learning physics as its focus is on the effects of learning strategies on students' satisfaction when learning physics, about which there are few studies.

Learning Strategies and Physics Education

Learning strategies can be defined as the behaviors and thought that a learner engages in during learning and that are intended to influence the learners' encoding process (Weinstein & Mayer, 1986). These strategies range from simple study skills, such as underlining a main idea, to complex thought processes, such as using analogies to relate prior knowledge to new information (Weinstein et al., 1989).

Weinstein and Mayer (1986), listed some of learning strategies into eight major strategies. The categories are: (1) Basic Rehearsal Strategies (such as repeating learning material), (2) Complex Rehearsal Strategies (such as copying, underlining or shadowing learning material), (3) Basic Elaboration Strategies (such as forming a mental image of learning material), (4) Complex Elaboration Strategies (such as paraphrasing or summarizing learning material), (5) Basic Organizational Strategies (such as grouping or ordering learning material), (6) Complex Organizational Strategies (such as outlining a passage or creating a hierarchy), (7) Comprehension Monitoring Strategies (such as checking for comprehension failures) and (8) Affective and Motivational Strategies (such as being alert and relaxed, to help overcome test anxiety).

Learning strategies have long been a subject highly valued by educators. The learning-strategies-related studies conducted between the early 1990s to 2008 have become miscellaneous through the analysis of some variables such as proficiency, learning environment, ethnicity, age, gender, learning styles, motivation, and beliefs. It has been identified that an individual's learning proficiency directly affects the range of learning strategies employed. Moreover, environmental factors play an important role in how learning takes place and also on the strategies used in the learning process (Nambiar, 2009). Moreover, the surveys that have been conducted about learning strategies over the last thirty years have focused mainly on strategy teaching that helps students to improve their performance (Simpson & Nist, 2000). The results of several studies conducted in this field have proved that effective learning strategies contribute greatly to the students' performance and also that the strategies can be taught (Protheroe, 2002).

Although there are many studies about the teaching of learning strategies in physics literature, there are few studies related to the use of learning strategies in physics. Physics education research on learning strategy instruction reported that strategy instruction had positive influences on students' conceptual learning (Harper, Etkina & Lin, 2003), achievement in physics (Çaliskan, Sezgin Selçuk & Erol, 2010a; Ghavami, 2003; Sezgin Selçuk, 2004; Sezgin Selçuk, Sahin & Açikgöz, 2009; van Weeren et al., 1982), reading comprehension (Koch & Eckstein, 1991; Koch, 2001; Rouet et al., 2001), problem solving performance (Austin & Shore, 1995) and the use of higher level learning strategies (Vertenten, 2002). Research also suggests that higher level strategies are expected to promote conceptual understanding (Brown et al., 1983; Entwistle & Ramsden, 1983).

Unfortunately, the instruction of learning strategies in physics is neglected in Turkey and there are very few studies in the field of physics (Çaliskan, 2007; Çaliskan et al., 2010a; Gök, 2006; Sezgin Selçuk et al., 2009; Sezgin Selçuk, 2004). Furthermore, this subject are is not given sufficient importance in our training system. It is neglected as the period of training is limited, course programs are loaded, or the teachers themselves do not have sufficient knowledge in the field.

Conceptual Learning, Learning Strategies and Physics Education

Conceptual learning involves understanding and interpreting concepts and the relationship between concepts. Conceptual learning emerges as a result of combining existing input with new information enabling it to be comprehended (Arslan, 2010). When evaluating the effectiveness of specific conceptual learning, one can use various instruments such as “detailed student interviews”, “open-ended examination problems”, and “multiple-choice diagnostics” (e.g. FCI, Hestenes, Wells & Swackhamer, 1992; FMCE, Thornton & Sokollof, 1998) (Redish & Steinberg, 1999). Besides the use of these instruments, literature shows that methods like concept mapping or drawings also help students to improve conceptual learning.

Literature in physics education show that diagnostic tests have been commonly used to spot students’ conceptual learning and conceptual misunderstandings over the last 20 years. In addition, the focus of the majority of the research is particularly on mechanics and electromagnetism (e.g. Crouch & Mazur, 2001; Demirci, 2010; Savinainen & Scott, 2002). Furthermore, there are also several studies that used interviewing techniques (e.g. Osborne & Gilbert, 1980) as well as open-ended questions for analyzing various subjects in physics (e.g. Cochran & Heron, 2006; Huffman, 1997).

In the light of this information, it can be concluded that conceptual learning has a major role in the field of physics education. In addition, a number of studies analyzing the effects of learning strategies on conceptual learning have been discovered in related literature (Gaigher, Rogan & Braun, 2007; Harper et al., 2003; Leonard et al., 1996; Numan & Sobolewski, 1998; Zieneddine & Abd-El-Khalick, 2001). Moreover, although there are some studies claiming that teaching learning strategies has no influence on students’ conceptual learning (Huffman, 1997), many studies verify that teaching learning strategies has a positive effect on students’ conceptual learning.

For example, the effects of structured problem-solving instruction on students’ problem solving skills and conceptual understanding of physics were investigated in a recent experimental study (Gaigher et al., 2007). The study revealed that the structured problem-solving group showed better physics conceptual understanding and tended to use a more conceptual approach in problem solving. Harper, Etkina and Lin (2003) used structured weekly journals in order to foster student questions about the learning material. The resulting questions were collected for one quarter and coded based on difficulty and topic. Students also took several conceptual tests during the implementation. The reports contained more questions than typically observed in a college classroom, but the number of questions asked was not correlated to conceptual performance. An investigation of the relationships among different types of questions and performance on these tests revealed that deeper-level questions that focus on concepts, coherence of knowledge, and limitations were related to the variance in student conceptual performance. Using qualitative problem-solving strategies, Leonard, Dufresne and Mestre (1996) taught an introductory, calculus-based physics course by highlighting the role played by conceptual knowledge in solving problems. The study identified the strategies as effective instructional means for helping students to identify principles that could be applied to solve specific problems, as well as to recall the topics covered in the course. In another study, Numan and Sobolewski (1998) investigated the influence of explicit problem solving instruction on students' problem solving ability and conceptual understanding as compared to instruction in textbook style problem solving. The Force Concept Inventory (FCI) was used to measure students' conceptual understanding at the beginning and at the end of the semester. In addition to the FCI, students' reasoning in multiple choice questions and their responses to multistep problems were analyzed to obtain a complete assessment of students' conceptual understanding and problem solving skills in both groups. The results of the study indicated a significant difference between the explicit problem solving group and the textbook style problem solving group in students' conceptual understanding and problem solving performance in favor of the former. Zieneddine and Abd-El-Khalick (2001) assessed the effectiveness of concept maps as learning tools (or strategies) in developing students' conceptual understanding in a physics laboratory course, and explored students' perceptions regarding the usefulness of concept maps in the laboratory.

Huffman (1997), who conducted a study to determine the effects of teaching explicit problem-solving strategies in physics teaching at high school level on students' conceptual learning skills through three open-ended questions related to FCI and Newton's laws, concluded that there was no significant difference between the strategy teaching group and the control group. In addition, he also put forward that female students benefit from strategy teaching more than their male peers.

Learning Satisfaction and Physics Education

As a way of monitoring and improving the quality of teaching, student evaluations have become a part of life at universities (Kwan, 2001). According to Kwan (1999), these evaluations are used as one (sometimes the only and often the most influential) measure of teaching effectiveness. As well as the helpfulness of the "Student evaluation of teaching"

(SET) in improving the teaching performance of the faculty lecturers, it can be also effective at the decisions of executives about the lecturers (e.g., promotion and tenure decisions) (Loveland, 2007; Morgan, Sneed & Swinney, 2003). According to many researchers student evaluations are a valid, reliable, and worthwhile means of evaluating teaching (Wachtel, 1998). There are several reports showing that students' evaluations of the efficiency of the teaching are commonly used to understand the quality of the teaching methods used as well as students' satisfaction with learning physics, and also in educational psychology surveys (Marsh, 1987).

In higher education, student satisfaction is one of the important indicators of quality (Erdogan, Usak & Aydin, 2008). Student evaluations can be used to measure student satisfaction. Satisfaction measures include different dimensions such as instruction and instructors, courses, majors, student services, facilities, academic services and campus climate (Sezgin et al., 2000). Similarly, Chien (2007) claims that learning satisfaction is made up of five fundamental elements; individual characteristics, teacher's attitude and skills, characteristics of the course, the learning environment and teaching objectives.

Hui et al (2008) define learning satisfaction as the perception of success and the positive feelings one has when he is successful. Erdogan et al (2008) describe the concept of satisfaction as an object, situation that meets a person's needs, or his attitude towards a situation. In the light of this information, in the present study, satisfaction is defined as the degree to which students feel satisfied with physics courses (i.e., students' overall course satisfaction concerning workload of course, level of course, teaching activities and instructors' teaching effectiveness).

There have been several studies on satisfaction. They mostly analyze the effect of satisfaction, which is a very significant variable for assessing the efficiency of teaching methods like online courses, web-based courses and distance learning. (e.g. Arbaugh & Duray, 2002; Blackwell et al., 2002; Hui et al., 2008; Mourtos & McMullin, 2001; Ryan, 2000; Sue, 2005; Sahin, 2008) There are also some studies showing that teaching methods like PBL or cooperative learning have a positive effect on satisfaction (Khaki et al., 2007; Kingsland, 1996; Klein & Pridemore, 1992). So, in order to improve the quality of teaching, some studies concerning learning satisfaction have focused on discovering the factors affecting it. For example, a survey conducted by Binner et al (1994) set forth that factors such as a teacher's attitude towards teaching, course materials and classroom management have a direct influence on learning satisfaction.

On the other hand, it has been identified that there are few studies analyzing learning satisfaction in the fields of science (e.g. Erdogan et al., 2008, 2009; Erdogan & Usak 2004, 2006, 2007; Hermanowicz, 2003; Telli, Rakici & Çakiroglu, 2003) and physics teaching (e.g. Brekelmans et al., 1997; Sezgin et al., 2000; Sezgin Selçuk & Çaliskan, 2010a; Sezgin Selçuk & Çaliskan, 2010b; Welch, 1969). To illustrate, Erdogan et al (2008) researched the facilities that a group of trainee chemistry teachers have in their departments and faculties in addition to their satisfaction with them. The researchers observed whether those students' learning satisfaction varied depending on the universities they attend and their genders as well. They eventually came to the conclusion that gender has no effect on learning satisfaction; whereas, the universities they are enrolled at definitely has. What is more, Hermanowicz (2003) studied scientists and satisfaction. Brekelmans et al (1997), on the other hand, studied the impact of learning satisfaction on success in mathematics and physics. They discovered that learning satisfaction influences success in mathematics more than it does in physics. Welch (1969) researched the factors influencing students' satisfaction with physics courses at high school level. Sezgin et al (2000), in their study examining university students' satisfaction with the physics laboratory, discovered that satisfaction did not change according to gender, freshman students had a higher level of satisfaction with the teaching process when compared to other students in senior classes, and their satisfaction with the physics laboratory changed depending on their departments. Sezgin Selçuk and Çaliskan (2010a) noted that the level of learning satisfaction of the pre-service teachers' that were taught in the Introduction to Physics course based on problem solving methods was significantly higher than the ones who were taught the same course based on traditional methods. In another study, Sezgin Selçuk and Çaliskan (2010b) put forth that the gender and academic success of pre-service teachers had no effect on their learning satisfaction.

In the literature, there is no study investigating the relationship between students' learning satisfaction and learning strategies used in physics teaching. On the other hand, there are a few studies examining the effect of the teaching of learning strategies on learning satisfaction (Brown, 2009; Kaenin, 2004).

In brief, for all of the afore mentioned reasons regarding the necessity of investigating the effects of strategy instruction on conceptual learning in a physics course, especially on students' learning satisfaction towards the course in the field literature, this research aims to evaluate the correlations between present research and these variables. Furthermore, this research hopes to make new contributions in the field of physics education literature.

The present study

Mestre et al. (1993) stated that two important goals of physics instruction were to help students achieve a deep, conceptual understanding of the subject and to help them develop powerful problem solving skills. In light of this statement, we designed our explicit summarizing instruction which is integrated content instruction.

Summarizing is the students' brief restatement of the main points learnt either verbally or in written form (Açikgöz, 2002). This learning strategy strengthens the relationship between the new ideas taught in the teaching material, and enables students to establish a bond between the newly and previously learnt knowledge (Sezgin Selçuk, 2004). Hence, the main purpose of this study is to examine the effects of summarizing strategy instruction on student teachers' conceptual learning in electricity and magnetism, and learning satisfaction. The research questions investigated in this study were as follows:

1. Are there any effects of using summarizing strategy instruction on pre-service teachers' conceptual learning scores?

2. Are there any effects of using summarizing strategy instruction on pre-service teachers' learning satisfaction?

Methodology of Research

Participants

The participants included 36 second-year pre-service teachers who were enrolled in the Department of Elementary Mathematics Education (EME) in Dokuz Eylül University (Dokuz Eylül University or DEU is a Turkish medium university) in Izmir. Students were randomly divided into two groups and assigned as section A and B. Physics is compulsory in this department, and it is offered in two successive semesters (fall and spring) as Physics I (4 credits) and Physics II (4 credits). Physics I mainly focuses on mechanics concepts and Physics II focuses on electricity and magnetism. The distribution of participants according to gender and groups is presented in Table 1.

Table 1. The distribution of participants according to gender and groups

Gender	Summarizing Group		Control Group		Total
	n	%	n	%	
Male	7	38.9	8	44.4	15
Female	11	61.1	10	55.6	21
Total	18	50.0	18	50.0	36

Note: n: number of participants in groups; %: percentage of participants in groups

Research Design

In this study, a pretest-posttest quasi-experimental method with equivalent control group was used. There was one control and one experimental group, namely, the summarizing group. Students were assigned randomly to the summarizing and control groups. The summarizing group received strategy plus traditional instruction; however, the control group received only traditional instruction. Both groups were tested before and after the intervention to measure their conceptual learning in electricity and magnetism, and learning satisfaction. Control variables were prior conceptual learning in electricity and magnetism, and learning satisfaction. The independent variable was the intervention (the strategy and/or the traditional instruction). The dependent variables were post-test conceptual learning in electricity and magnetism, and learning satisfaction.

Materials

The data of this study was collected by a Conceptual Learning Open-Ended Test (CLOET), and a Student Satisfaction Scale (SSS).

Conceptual Learning Open-Ended Test (CLOET): CLOET is an open-ended test designed to determine the level of students' conceptual learning in electricity and magnetism. When designing this test, the researcher selected ten questions requiring short answers from the book PHYSICS for Scientists and Engineers (Serway & Beichner, 2000) for the subjects of electricity (electric field, Gauss's Law, electric potential, capacity and dielectric, current and resistance, d.c. circuit) and magnetism (magnetic field, magnetic force, Biot-Savart Law, Ampere's Law, magnetic flux). She took three experts' opinions on the validity of the test and whether it, in parallel with the teaching objectives, could be used for setting conceptual learning or not. The sample questions are all given in Appendix 1. The students were asked to make detailed oral explanations using the fundamental laws of physics, make the necessary drawings, and write the formulas clearly when answering the questions. They were allocated 40 minutes to answer the questions. The answer given to each question has been graded according to the rubric presented in Table 2.

Table 2. Rubric for Grading the CLOET

Answer Criteria	Point	Criteria Definition
Correct answer	10	Giving an explanation that is correct in physics, drawing the right figures and writing the correct formulas
Partially-correct answer	5	Giving insufficient explanation, figures and formulas
Incorrect answer/ No response	0	Giving incorrect explanation, figures and formulas No answer

According to the CLOET Assessment Scale, the maximum score that one can get from the conceptual test is 100, and the minimum score is 0.

In order to determine the validity of the evaluation of the CLOET test, the researcher graded the students' papers twice with intervals of three weeks; and the Pearson' correlation coefficient between the scores was calculated as 0.88.

The Student Satisfaction Scale: Students' learning satisfaction towards learning physics was measured using the Student Satisfaction Scale (SSS) developed by Sezgin Selçuk and Çaliskan (2010a). This scale containing 5-choice Likert type items having choices of "Totally Agree", "Agree", "Undecided", "Disagree", and "Totally Disagree" consists of a total of 26 items. Satisfaction items are scored using values ranging from 5 (Totally Agree) to 1 (Totally Disagree). Negative items are inversely coded. Items in the scale are grouped in 3 dimensions and can explain 49.30% of total variability. The names of the dimensions are as follows: Enjoyment in Learning (EL), Quality of Teaching (QT), and Teaching Activities (TA). Descriptions and sample items concerning sub-scales of SSS are given in Table 3.

Table 3. Descriptions and sample items concerning sub-scales of student satisfaction scale

Sub-scales	Descriptions	Sample Items
EL	Satisfaction with the course itself.	"I don't want the course to end"
		"We are having lots of fun during classes"
QT	Satisfaction with the quality and adequacy of teaching.	"I always receive an answer to my questions in classes"
		"I think that what we cover in classes is sufficient"
TA	Satisfaction with the teaching and learning activities conducted in classes.	"Our teachers are always teaching us theories, we never practice"
		"Our teachers do not encourage us to participate in classes"

Item analysis of the SSS resulted in a 26-item scale with a coefficient of 0.92 (Cronbach's Alpha), indicating an excellent level of reliability. Of the 26 items, 14 items were positive and 12 were negative. The highest score which can be obtained from this scale is 130, and the lowest score is 26 (for rating 5 to 1 all twenty-six items). In Table 4, the number of items for each sub scale calculated using Cronbach's Alpha reliability coefficients are presented.

Table 4. Results of the reliability calculations concerning the student satisfaction scale

	Sub-scales	Number of items	Cronbach's Alpha Coefficient
Sub-scale 1	EL	14	0.92
Sub-scale 2	QT	7	0.80
Sub-scale 3	TA	5	0.67
Whole Scale		26	0.92

Intervention Materials: The Turkish translation of the textbook Physics for Scientists and Engineers with Modern Physics 2 by Serway and Beichner, 5th edition (2000) was used as the textbook in both groups. During the instruction process, scripts which contain information about summarizing strategies and work sheets (i.e. used to write summaries) developed by the researcher were used in summarizing groups. A sample sheet for summarizing strategy is presented in Appendix 2.

Procedure

The experimental processes were conducted in four classes per week of General Physics II. The intervention took place over six weeks (24 classes) in total in March and May in the Spring Semester of the 2009-2010 academic year. During the first week of the semester, before the experimental processes, the pre-tests measures of conceptual learning, and learning satisfaction towards physics were collected and during the second week, the summarizing strategies training program was applied to the strategy training group during 2 lecture hours (a total of 180 minutes). During the intervention, the summarizing group received explicit summarizing strategies plus traditional instruction in a whole-class format, while those in the control group received only traditional instruction in a whole-class format. Strategy instruction in the summarizing group composed of two training phases called strategy acquisition and strategy application as used in Montague and Bos (1986). In the first 90 minutes of the class, the researcher taught Coulomb's Law both to the summarizing and control group with a traditional method. In the second 90 minutes of the class, the researcher used "strategy acquisition" and "strategy use" methods when working with students. In the control group, during the same class hour, the students revised the subject matter and they solved some example problems. In terms of content, both groups were in parallel to each other. Posttest measures of conceptual learning, and learning satisfaction towards physics were collected at the end of the treatment period, that is, at the beginning of the ninth week.

Treatment in the summarizing group

The summarizing group was taught the strategies in two consecutive class hours. In the first 90 minutes of the first class of the week, using traditional methods, the researcher taught Coulomb's Law. The activities carried out during strategy-teaching in the second 90 minutes are given below:

1) The students were introduced to summarizing strategies.

2) The researcher explained the purpose and importance of summarizing and how and where it would be used.

3) When summarizing, the students were encouraged to use The Rule-Based Summarizing Strategy, which was developed by Brown, Campione and Day (Maher, 2000). When using this strategy, students have to follow some rules.

The following steps of The Rule-Based Summarizing process were explained to the students:

a) to detach the unnecessary information,

b) to throw away the excess material,

c) to replace special concepts with more general concepts in the material (e.g., dielectrics for mica, quartz, and plastic), and

d) to choose a title for the summary.

4) The students were presented some examples about summarizing.

5) In order to enable the students to practice summarizing, they were invited to go over Coulomb's Law again and summarize the subject in accordance with the rules for summarizing.

6) The researcher examined the students' summaries immediately and gave them feedback.

Strategy application training was started in the third week of the semester and was embedded into the content of traditional instruction. Approximately 60 minutes of class time each week was used for presentation and the remaining time was left for individual summarizing activities. After the presentation, a "Summarizing Sheet" was distributed to students and they were asked to review the learning material and write a summary of the lecture by using graphic organizer(s). The Summarizing Sheets were collected at the end of the class. Student sheets were reviewed by the researcher and the first 10 minutes of the next class was reserved for the evaluation of these activities. Deficiencies and mistakes (if any) in the summarizing sheets were discussed during student-researcher dialogues. The remaining part of the class was left for traditional problem solving activities.

Treatment in the control group

While strategy instruction was applied in the summarizing group, no study relating to strategy instruction was carried out in the control group. During this period, conventional teaching methods were used concerning "Coulomb's Law" the same topic covered in the strategy group training program. In the control group, the subject of that day was instructed by the researcher using a direct lecturing method for the first 90 minutes of the time allotted in the course schedule. After the instruction of the lecture was completed, similar sample problems solved by the strategy group were solved by the researcher on the board for the students in the control group using traditional problem solving approaches. To enable both groups to catch up with each other in terms of syllabus, whenever the control group covered that day's material, they were asked to revise that teaching material such as the subject matter and example problem solutions.

Data analysis

The data obtained from CLOET, and SSS have been analyzed using the SPSS 13.0 statistical analysis program. Frequencies (n), percentages (%), means (M), medians (MD) and standard deviations (SD) were calculated.

We cannot assume that the dependent variables had normal distribution due to the small number of the sample in each group: $n1$ and $n2<20$. Hence, non-parametric tests were required to be used during the analysis of the data (Pett, 1997). The non-parametric statistical methods, the Mann-Whitney U test and the Wilcoxon Signed-Rank test, were conducted. We used an alpha level of 0.05 for all of the statistical tests.

Results of Research

The descriptive statistical information regarding the students' pretest and posttest scores from CLOET, and SSS sub-scales is presented in Table 5.

Table 5. Descriptive statistics regarding CLOET, and SSS scores

Dependent variable		Pretest						Posttest					
		SG (n 1=18)			CG(n 2=18)			SG (n 1=18)			CG(n 2=18)		
		M	MD	SD	M	MD	SD	M	MD	SD	M	MD	SD
CLOET		19.72	15.00	11.82	17.78	15.00	8.78	74.44	75.00	14.34	60.83	60.00	15.93
SSS	EL	44.67	44.00	4.70	46.05	45.00	7.14	44.94	45.50	6.36	44.50	45.50	6.33
	QT	25.89	26.00	2.42	26.05	26.00	2.15	23.61	24.50	4.07	23.88	24.00	4.27
	TA	15.50	15.00	2.81	16.05	15.50	3.40	15.33	15.50	2.52	13.55	14.00	2.83

The effects of summarizing strategy instruction on students' conceptual learning in physics

It was checked whether there was a significant difference between the SG and the CG students' rate of conceptual understanding in electricity and magnetism before and after the test. In order to do so, considering both their pretest and posttest scores, the Mann-Whitney U test was used with independent samples. To do this, students' mean ranks and sum of ranks have been determined in view of their Conceptual Learning Open-Ended Test (CLOET) pretest and posttest scores. Statistically, there is no important difference between the SG and CG students' pretest mean ranks regarding the CLOET (Mann-Whitney $U=152.50$ $z=-0.307$, $p>0.05$); however, the difference between their posttest mean ranks was extensive in favor of the SG (Mann-Whitney $U=82.50$ $z=-2.545$, $p<0.05$ two tailed).

The Wilcoxon Signed Ranks Test was used in order to test the significance of the difference between the pretest and posttest median scores of the SG and CG students. There was a considerable increase in both the SG (from 15.00 to75.00) and CG's CLOET median scores (from 15.00 to 60.00) as it moves from pretest to posttest ($z=-3.746$, $p<0.05$; $z=-3.728$, $p<0.05$, respectively).

The effects of summarizing strategy instruction on students' learning satisfaction in physics

The difference between the SG and traditional method group students' pretest and posttest scores respecting their learning satisfactions towards physics course was checked and it was determined whether this difference was an important one or not. For this reason, a series of Mann-Whitney U tests were conducted. There was no significant statistical difference between the SG students and CG students' pretest and posttest mean ranks regarding the all subscales (EL, QT and TA). For pretests: Mann-Whitney $U=142.00$ $z=-0.634$, $p>0.05$; Mann-Whitney $U=160.00$ $z=-0.064$, $p>0.05$; Mann-Whitney $U=155.50$ $z=-0.207$, $p>0.05$, respectively. For posttests: Mann-Whitney $U=152.50$ $z=-0.302$, $p>0.05$; Mann-Whitney $U=155.00$ $z=-0.223$, $p>0.05$; Mann-Whitney $U=107.50$ $z=-1.738$, $p>0.05$, respectively.

The Wilcoxon Signed Ranks Test was used in order to test how significant the difference between the pretest and posttest median scores of the SG and CG students was. There was a slight increase in the SG's EL and TA median scores as it moved from pretest (MD=44.00; MD=15.00, respectively) to posttest (MD=45.50; MD=15.50) ($z=-0.480$, $p>0.05$; $z=-0.457$, $p>0.05$, respectively); while, there was a slight decrease between their QT median scores (from MD=26.00 to MD=24.50) ($z=-1.595$, $p>0.05$).

According to the values, there was no significant change between the CG's El and QT median scores as they move from pretest to posttest. There was a slight increase in the CG's EL median scores as it moved from pretest (MD=45.00) to posttest (MD=45.50) ($z=-0.181$, $p>0.05$); while, there was a slight decrease between their QT median scores (from MD=26.00 to MD=24.00) ($z=-1.564$, $p>0.05$). However, there was a substantial decrease in the CG's TA median scores as it moved from pretest (MD=15.50) to posttest (MD=14.00) ($z=-1.996$, $p<0.05$).

Discussion

The purpose of this study is to evaluate the effects of summarizing instruction, on pre-service teachers' conceptual learning in electricity and magnetism, and learning satisfaction towards an introductory physics course. In the light of the analysis results, it may be deduced that summarizing strategies instruction impacted students' conceptual learning positively. However, it has been determined that summarizing strategies instruction has no impact on students' learning satisfaction.

The first result of the study is consistent with the findings of strategy instruction research in physics education literature (Gaigher et al., 2007; Harper et al., 2003; Leonard et al., 1996; Numan & Sobolewski, 1998; Zieneddine & Abd-El-Khalick, 2001). During this research, it could clearly be seen that the instruction applied in the strategy group was far more effective than that applied in the control group. This was evident in class observations where it was observed that students in the summarizing group reviewed the learning materials; actively participated in the summarizing process; and always read the texts very carefully identifying the main points, terms and concept; drew figures and wrote the important formulas. During the summarizing process, students are required to use their prior knowledge and find their shortcomings in learning.

In the research, it was determined that there were significant differences in the progress of both groups from pretest to posttest. Although it was expected that students in the control group would make some progress, in this context, this result can be interpreted as a result of the students willingness to study in order to pass the course or to get higher scores. During the research, it was observed that the students in the control group also actively participated in the traditional lectures by taking notes and asking questions.

In the study, it was observed that teaching a summarizing strategy did not create an important difference between both groups' learning satisfaction towards physics courses. Likewise, Sue (2005), in her research, did not observe any significant difference between the learning satisfaction of the students in online statistics classes and the ones in face-to-face statistics classes. In the same way, Ryan (2000) also claimed that there was no significant difference between the quality perception by the students attending online classes and the ones attending traditional classes.

However, unlike there afore mentioned studies, in the literature, almost all of the studies that have applied either a teaching method or a teaching strategy such as cooperative learning, PBL or web-based learning (Khaki et al., 2007; Sezgin Selçuk & Çaliskan, 2010a) or that investigated the influence of teaching learning strategies on students' learning satisfaction (Brown, 2009; Kaenin, 2004), inferred that teaching students learning strategies definitely has a positive effect on their learning satisfaction.

In the study, at all levels in the SG, there was no significant difference between the students' level of learning satisfaction from the pretest to the posttest. Yet, it has been observed that there was a dramatic decline at TA level in the CG starting from the pretest up to the posttest. The decline regarding the students' satisfaction with the teaching activities might have resulted from the fact that the students in the control group were taught with traditional methods and also that no extra activities were conducted other than problem solving. In this context, in other words, the reason for the regression in satisfaction towards TA in the control group can be attributed to the style of instruction which did not include instructional tasks where the students felt satisfied in terms of teaching activities (e.g. summarizing or strategic problem solving).

Conclusions, Limitations and Suggestions

This study provides some evidence of the positive effects of using summarizing instruction in an introductory physics course on student teachers' conceptual learning. For the participating students, summarizing learning strategy instruction was more effective than traditional instruction in terms of improving conceptual learning in physics. Furthermore, it was noted that when teaching with traditional methods, the teaching of summarizing strategy did not affect students' learning satisfaction at all.

By teaching summarizing strategies, the students were encouraged to actively participate in the activity. Thus, the researchers made a great contribution to the students learning as they have become able to better comprehend a subject in physics through summarizing, and as a result of which they have also become able to differentiate between relevant and irrelevant inputs, and have turned out to be outstanding individuals who are really aware of what they are learning and can use strategies properly.

Although the students have improved their conceptual learning skills, it has not affected their learning satisfaction. The reason for this could be the fact that the students in both groups were taught through traditional methods. In the strategy group, the researchers spent rather less time on summarizing activities in comparison with the time spent on traditional methods. So, it is very normal to say that there was no improvement on the components describing the students' satisfaction with the quality and methods of the teaching. Besides, the fact that the all the experiments were conducted in a limited time frame of only in six weeks might be another reason for having little effect on learning satisfaction.

The fact that the study was carried out within a regular teaching program has limitations on this study. Firstly, the study has been conducted within a six-week period. It is thought that any long term future studies on the same theme may prove to be useful in producing more positive effects on the results. Secondly, in this research, instead of overtly attempting to develop the students' learner satisfaction, a strategy instruction program providing the students with the opportunity to actively participate in the summarizing sessions, emphasizing the importance of summarizing strategies usage would be beneficial. Thirdly, there were only

36 participants in the complete study. Being conducted with a small group poses a threat to the external validity to research. Thus, we may not be able to generalize the findings. This study must be conducted on the same subject, but with a larger sample so as to obtain results that can be generalized. Moreover, in further research, by supporting a strategy instruction program combined with a satisfaction improvement program which can be applied in addition to a normal instruction program, more effective results could be obtained.

On the basis of the findings, it is recommended that physics instructors should use summarizing learning strategy instruction in their lessons to develop students' learning to learn skills and the related outcomes such as conceptual learning. In addition, the factors affecting students' learning satisfaction during physics courses should be researched thoroughly through some more studies. Following that, depending on the findings, some of the teaching methods and activities used might have to be changed and adapted so as to increase students' level of satisfaction with the courses. Research where the effects of instruction of different learning strategies in different grade levels on a physics course and different effective characteristics (e.g. learning approaches and anxiety) are investigated should also be done. Learning strategies and courses intended to instruct these strategies should be added to the curriculums of the institutions involved in the education of teachers.

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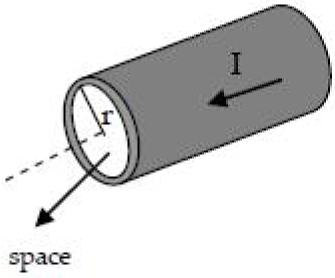
APPENDIX

APPENDIX 1. Example Questions for CLOET

Question 1. "A balloon is charged negatively by friction. Then you can hold it to the wall. Does this mean that the wall is charged positively? Explain it both orally and schematically".

Question 7. "Can a static magnetic field activate a static electron? Explain it by drawing the necessary figures and writing the correct formulas."

Question 10. "A hollow copper tube carries a current along its length. Why is B=0 inside the tube? Isn't B zero outside the tube?



APPENDIX 2. Sample summarizing sheet

SUMMARIZING SHEET

Name, Surname: ……………………………………….. Date: ………………………….

Students ID no: ………………………………………

SUBJECT(S): ……………………………………………………………………………………

……………………………………………………………………………………………………..

……………………………………………………………………………………………………..

What are the most important things you have learnt about these subject(s)? List them.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

Visualize what you have learnt so far by drawing figures, graphs, tables and/or diagrams.

What are the parts that I could not understand well?

……………………………………………………………………………………………………