Using the Classroom Response System to Enhance Students' Learning and Classroom Interactivity

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Suggested Citation:

Gök, T. (2011). Using the classroom response system to enhance students' learning and classroom interactivity. *Eurasian Journal of Educational Research*, 45, 49-68

Abstract

Problem Statement: In science education conceptual learning is a key factor to understand the subjects and to solve the problems. Students should begin to learn the subjects on the conceptual level and then solve problems of related concepts. Unfortunately, most of the researches have shown that students generally tend to solve problems without understanding fundamental concepts. Studies indicated that current traditional instruction methods are not effective on the conceptual learning. In this research, an educational technology which would be effective on students' conceptual learning was used. This technology, which is used widely in Europe and USA is called "Clicker" or Classroom Response System (CRS). In the present study, this technology was used in conjunction with Peer Instruction approach.

Purpose of Study: In this study, the effects of clicker on students' conceptual learning achievement and interaction (individual and class) were examined.

Method: The quasi-experimental design was used in this study. Students included in control group used flashcard while the ones in experimental group used clicker while answering concept tests. Peer Instruction (PI) method was used for both groups. The achievement of the students on conceptual learning was monitored by Conceptual Survey of Electricity and Magnetism (CSEM) and the individual. Overall interaction of the students in the class was quantified by Interactivity Instrument. Both sections were taught by the same lecturer. Lecturer established a detailed timeline of procedures for the study. During research, both sections received the same lectures using the same PowerPoint slides.

Findings and Results: As a result of the research, the conceptual learning achievement of students in the experimental group was found higher than

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the students' in control group. Also, the results showed that the classroom response system and flashcards can significantly improve interactivity in the lecture.

Conclusions and Recommendations: In this research, it was found that the use of the clickers was effective on conceptual learning and interaction of the students. Author reports that students are attracted to the CRS system because it promotes active learning in a large/small-class environment. Also, when the clickers are evaluated as a whole, it can be concluded that clickers offer a powerful and flexible tool for teaching and learning. Clickers can be used in various subjects with students of almost any level of academic training. Based on the findings from this research, CRS offers such an opportunity for educators to adapt to the changing learning environment.

Keywords: clicker, classroom response system, concept learning, educational technology, peer instruction

Classroom Response Systems (Beatty et al., 2006) or "clicker" (Bergtrom, 2006), as they are commonly called, offer a management tool for engaging students in the classroom. Many lecturers at both large and small educational institutions have begun to use classroom technology that allows students to respond and interact via small, hand-held, remote keypads (Caldwell, 2007).

In order to comprehend the pedagogical developments in this area, it is necessary to understand the practical process of using CRSs. A typical pattern of use is as follows. During the lecture, the lecturer poses a question. Each student has a handset (clicker) that allows them to select the preferred option for the answer. The handsets transmit this information to a receiver, which in turn transmits it to the voting software on a computer in the class. The handsets transmit to the receiver using wireless technologies, depending on the particular system used. After the allotted time, the software produces a histogram or bar chart of the results, which is displayed to the students using a data projector to the computer. The lecturer then chooses an action to respond to the results. The software also allows the data to be recorded so that results can be analyzed later (see Figure 1).

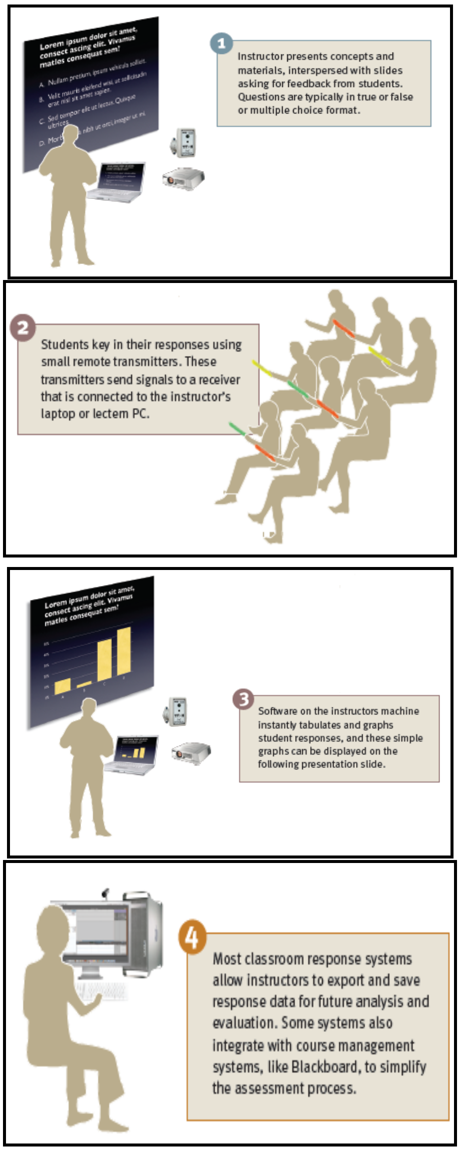

Figure 1. Schematic of Classroom Response System (Deal, 2007)

Most handsets allow multiple-choice responses, with up to ten answers available. The handsets can be used anonymously. However, the handsets can be mapped to a student's name. This allows the lecturer to see the individual's answer, either within the lecture or when reviewing responses at a later stage.

The key advantage of using CRS is that it can give feedback to both students and lecturers on how well the entire class understands the concepts presented. Once this feedback is obtained, a lecturer can modify the course of instruction, or students can work out misconceptions by peer or classroom discussion (Kay, 2009). CRSs have been used to improve student interaction, engagement, and attention (Draper & Brown, 2004; Hinde & Hunt, 2006), increase attendance (Bullock et al., 2002), stimulate peer and class discussion (Pelton & Pelton, 2006), provide feedback for both students and lecturers to improve instruction (Caldwell, 2007), and improve learning performance (El-Rady, 2006; Judson & Sawada, 2002; Kay & LeSage, 2009a; Kay & LeSage, 2009b). The fundamental differences between CRSs and traditional classrooms, benefits to using CRSs, and challenges associated with CRSs were given as follows.

Fundamental differences between CRSs and traditional classrooms

Feedback can be acquired by multiple means, asking volunteers to share answers, including a show of hands, use of small individual whiteboards or tables to display answers, or using colored cards (flashcard) to represent multiple-choice responses, in a traditional lecture (Draper et al., 2002; McCabe, 2006; Kay, 2009).

However these methods have notable drawbacks. A show of hands after students have answered a question for the second time is the simplest method. It gives a feel for the level of the class' understanding and allows the lecturer to pace the lecture accordingly. The main drawback is a loss of accuracy, in part because some students may hesitate to raise their hands and in part because of the difficulty in estimating the distribution. Besides, some students are inclined to copy the responses of others. In addition, when hands are lowered, the data is lost (Abrahamson, 2006; Burton, 2006; Pelton & Pelton, 2006; Slain et al., 2004). Other shortcomings are the lack of a permanent record and the lacks of any data collected before convincing your neighbor's discussion (Mazur, 1997).

In contrast to traditional lectures, CRS-based classroom has several key advantages. CRS allows students to enter their answers to the concept tests as well as their confidence levels, on a variety of handheld devices, ranging from graphing calculators to palmtop or laptop computers, which they share in small groups of three or four. Their responses are relayed to the lecturer on a computer screen and can be projected so the students see it, too. The main advantage of the system is that analysis of the results is available immediately. In addition, student information is available to the lecturer, making large classes more personal; the system can also handle numerical and non-multiple-choice questions, and sharing these handheld computers enhances student interaction (Beatty, 2004; Mazur, 1997; Pradhan et al., 2005).

Benefits to using CRSs

As identified in the introduction section, whilst voting systems can support teaching and learning within lectures, any benefits will depend on how effectively they are used on each occasion. In order to judge whether the system does, indeed, enhance the lecture format, it is first necessary to identify the assumptions that are made about what counts as "good" learning. From the reviewed literature, and the sources they draw from, three key principles (student involvement, assessment, and learning) have been identified:

With the respect to student involvement, there is considerable data to suggest that students using CRS are more engaged in concepts covered (Crouch & Mazur, 2001; Preszler et al., 2007; Reay et al., 2005; Reay et al., 2008; Simpson & Oliver, 2007), participate more (Bullock et al., 2002; Burnstein & Lederman, 2001; Caldwell, 2007; Draper & Brown, 2004; Greer & Heaney, 2004; Jones et al., 2001; Stuart et al., 2004), pay more attention in class (Bergtrom, 2006; Slain et al., 2004), and are more involved in class discussion (Beatty, 2004; Bergtrom, 2006; Nicol & Boyle, 2003; Sharma et al., 2005). One of the greatest benefits of CRSs is that they offer the opportunity to make the lecture "more interactive without appearing threatening" (Draper et al., 2002; Jones, 1999). It is likely that many students hold back from answering or responding through peer pressure or the potential embarrassment of publicly giving the wrong answer. This in turn may mean that only the more confident or able students respond, when they are least in need of lecturer attention (Durbin & Durbin, 2006; Fies & Marshall, 2006; Kay, 2009).

Regarding assessment, CRS helps improve the feedback cycle by ensuring anonymity, collecting, and summarizing responses from all students in larger classes very quickly, and limiting the copying of answers (Abrahamson, 2006; Beatty, 2004; Draper & Brown, 2004; Pradhan et al., 2005; Simpson & Oliver, 2007). In addition, the regular use of CRS can offer feedback to both the lecturer and students as to how well concepts are being understood (Bergtrom, 2006; Bullock et al., 2002; Dufrense & Gereca, 2004). Timely feedback to students about their performance can be greatly assisted by the use of CRSs. Because answers are marked electronically and automatically, feedback on performance and presentation of the right answers can be achieved quickly (Kay, 2009). Students can then see how their performance compares to that of the rest of the group. When used for peer assessment students can gain immediate feedback on their work. The lecturer can also gain feedback in this way. They can, for example, see how well the lecture has performed and use the information immediately to provide appropriate action such as re-describing a misunderstood item.

With respect to learning, numerous studies have reported that students feel they learn more when CRS is used in higher education classrooms (Greer & Heaney, 2004; Pradhan et al., 2005; Preszler et al., 2007). Furthermore, many experimental studies have been done where CRS-based classes score significantly higher on tests and examinations than classes who are exposed to traditional lecture formats (Kaleta & Joosten, 2007; Kennedy & Cutts, 2005; Reay et al., 2005; Reay et al., 2008).

Challenges associated with CRSs

Two main challenges have been associated with the use of CRS: technology and adjusting to a new method of learning. Two main technology-based difficulties were reported when using CRSs. First when students were responsible for purchasing their own remote devices, they did not consistently bring them to lecture or they were lost. Because of the lecture dependence on CRSs, students without remote devices were unable to fully participate (Caldwell, 2007; Reay et al., 2005). Second, a more critical technological issue occurred when remote devices did not function properly or the signal was not received by the lecturer's computer. This was a particularly stressful experience when students were being evaluated (El-Rady, 2006; Hatch et al., 2005; Kay & LeSage, 2009a; Sharma et al., 2005).

Regarding new methods of learning, some students react adversely to the use of CRS because the overall approach to learning changed. They are accustomed to lectures and a switch of methods leads to stress, frustration, and resistance at first (Abrahamson, 2006; Fagan et al., 2002; Trees & Jackson, 2007).

The above identified drawbacks are concerned with technology, instructional design, and students' attitudes. First, CRS is a new technology and has room for technological improvement and advancement. For example, students' responses sometimes could not be detected and received by the receiver. The receiver was not able to receive more than one concurrent response, or the transmitter was not within the range of the receiver. Second, CRS can only capture quantitative data, thus limiting the responses to multiple-choice or true-false questions. Third, since using the wireless handheld transmitter was fun to the students, some of them did not take it seriously-by clicking multiple times on purpose, by clicking on answers that were obviously incorrect or by clicking on answers that were out of the range/choices given (Siau et al., 2006).

Many researchers have discussed that there are several key problems with current research on CRSs including: a lack of systematic research, a bias toward using anecdotal, qualitative data, excessive focus on attitudes as opposed to learning and cognitive processes, and samples derived from limited educational settings. Several researchers (Caldwell, 2007; Fies & Marshall, 2006; Freeman et al., 2007) have noted that research on CRSs has been largely unsystematic. However, it is not clear what these researchers mean by ''systematic". According to review, many studies have been conducted in a thoughtful, planned manner where the learning impact of CRSs was calibrated (Bullock et al., 2002; Fagan et al., 2002; Kennedy & Cutts, 2005; Pradhan et al., 2005). However, data collection instruments are noticeably lacking in reliability and validity analysis. Only four studies reported estimates of validity and reliability (Penuel et al., 2007; Siau et al., 2006; Trees & Jackson, 2007). Therefore it is necessary to apply reliable data collection procedures.

In this study, the effects of the clicker on students' conceptual learning achievement and interaction were examined quantitatively. This study was conducted systematically on two groups during spring 2010 in an introductory physics course at the University of Dokuz Eylul, Turkey. Students included in the control group used flashcards while the ones in the experimental group used clickers while answering a concept test. Peer Instruction (PI) method was used for both groups. To analyze the research results, the conceptual learning achievement of the students included in the groups was monitored with the Conceptual Survey of Electricity and Magnetism (CSEM) and the individual and overall interaction of the students was monitored with the Interactivity Instrument.

Method

The quasi-experimental design was used in this study. The students included in the control group were instructed by Peer Instruction (PI) with "flashcards" while the students in the experimental group by PI with "clickers". Both sections were taught by the same lecturer. The lecturer established a detailed timeline of procedures for the study. During research, both sections received the same lectures using the same PowerPoint slides. The only difference between the two sections was that the students in the experimental group used clickers during the physics lectures (using 3-4 concept tests with peer discussion in each lecture). The students in the control groups used flashcards to answer the concept test in the lectures. For the flashcard group, each student had a set of six or more cards labeled A-F to signal the answer to a question. Before and after the implementation to both groups, the CSEM and Interactivity Instrument were administered as pre- and post-test.

Peer Instruction was selected as an instruction method for both groups. PI is a student-centered instructional approach developed at Harvard University by Mazur (1997). The method has been welcomed by the science community and adopted by a large number of colleges and universities due, among other reasons, to its common sense approach and its documented effectiveness (Crouch & Mazur, 2001; Mazur, 1997). Mazur's program PI modifies the traditional lecture format by including a design to engage students and uncover difficulties with the material.

The lecture taught with PI was divided into a series of short presentations, each focused on a central point and followed by a related conceptual question, called a conceptual test, which probed students' understanding of the ideas just presented. Students were given one or two minutes to formulate individual answers with others sitting around them; the lecturer urged students to try to convince each other of the correctness of their own answer by explaining the underlying reasoning. Finally, the lecturer called an end to the discussion, polled students for their answers, again explained the answer, and moved on to the next topic.

Participants

This research was conducted on an Introductory Physics course at the University of Dokuz Eylul in the spring 2010 semester. The author has examined the academic background of student groups (GPA "Grade-Point Average" and University Entrance Scores). No statistically significant difference between the students from the experimental and control group was found. Instruction in the experimental group was done via PI with clickers (n=35). Instruction in the control group was done via PI with flashcards (n=33) for responding of the concept tests.

Material

Instruments used in the research are eInstruction, Conceptual Survey of Electricity and Magnetism, and Interactivity Instrument.

eInstruction: The eInstruction® system was selected for the classroom response system (CRS). The system includes handheld key pads for students, a receiver, and software. The software allows for integration of the results with Microsoft Office so the results can be automatically displayed within a PowerPoint presentation; responses can be tracked and recorded via its software, Excel or Microsoft Word.

Conceptual Survey of Electricity and Magnetism: The CSE (Conceptual Survey in Electricity) and the CSM (Conceptual Survey in Magnetism) were precursors to the CSEM (Conceptual Survey of Electricity and Magnetism) developed by Maloney et al. (2001). Their goal was to devise a single assessment tool that could be used to quantitatively evaluate students' pre and post instruction knowledge of electricity and magnetism. The CSEM was a 32-question, multiple-choice test developed to assess students' knowledge about topics in electricity and magnetism. It has been revised many times and has been given in various forms to more than 5000 introductory physics students at 30 different institutions.

The CSEM addresses fundamental conceptual areas in electricity and magnetism. These include: (1) charge distribution on conductors/insulators, (2) Coulomb's force law, (3) electric force and field superposition, (4) force caused by an electric field, (5) work, electric potential, field, and force, (6) induced charge and electric field, (7) magnetic force, (8) magnetic field caused by a current, (9) magnetic field superposition, (10) Newton's third law applied in electricity and magnetism, and (11) Faraday's law.

In evaluating the content validity of the CSEM, 42 two-year college physics professors rated each item on a Likert scale (1 being low and 5 being high) for both reasonableness and appropriateness. All of the items on the CSEM were rated as both highly reasonable and appropriate (Mean scores are all above 4). The posttest estimates for KR-20 (Kuder-Richardson) reliability coefficient of the CSEM was 0.75 (Maloney et al., 2001).

Interactivity Instrument: To examine the effect of the CRS on interactivity in the lectures accurately and systematically, the Interactivity Instrument was used in this research. This instrument was developed by Siau et al. (2006). Interactivity can be measured through 1) students' involvement in the lecture, 2) students' engagement in the lecture, 3) students' participation in the lecture, 4) students' receiving feedback from lecturers, and 5) students' self-assessment. Each question (ten questions) is measured using a nine-point Likert scale with 1 representing "strongly disagree" and 9 representing "strongly agree".

For this instrument, individual interactivity may be different from overall classroom interactivity. For example, the overall level of interactivity may be high (i.e., most students participate in discussion and interact with the lecturer), but specific students may not be participating and hence, their individual interactivity may be low. Therefore, individual interactivity and overall classroom interactivity were measured separately. The reliability of the instruments was assessed. The Cronbach's alpha coefficient for interactivity at the individual level is 0.86, and for interactivity at the class level is 0.90 (Siau et al., 2006).

Data Analysis Process

The CSEM and Interactivity Instrument were administered to all students enrolled in introductory physics. The courses were taught by the help of the PI in the experimental group and the control group. All students were given the option of not participating in the test, however, very few opted to not participate. The data collected have been analyzed with three different statistical analyses-fractional gains, effect size, and student's t-test.

$$\text{Fractional Gain (FG)} < g >= \frac{(\text{post\%} - \text{pre\%})}{(100\% - \text{pre\%})}$$

This equation is used to calculate fractional gains. Where <g> is the fractional gain, post% is the percent score on the post-test, and pre% is the percent score on the pre-test. The difference in score is normalized by the maximum possible gain. This method of evaluation was introduced by Hake (1998) when he made a large scale comparison of conceptual understanding gains between interactive-engagement and traditional methods of teaching physics. Hake (1998) defined a high gain to be greater than or equal to 0.7, medium gain to be less than 0.7 and greater or equal to 0.3, and low gain to be less than 0.3. On average, he found that traditional courses tended to have low gain while interactive-engagement courses tended to have medium gain (Hake, 1998).

The effect size normalizes the difference in score by the standard deviation and is calculated using the following equation

$$\text{Effect Size (ES)} = \frac{< \text{post} > - < \text{pre} >}{s}$$

Where <post> is the mean value of the post-test score, <pre> is the mean value of the pre-test score, and s is the standard deviation of the difference between the pre-test scores and post-test scores. Although there is some disagreement, usually, an effect size greater than 0.8 is considered to be large and greater than 0.5 is considered to be medium (Hinkle et al., 1998). By analyzing the data reported by Hake (1998), a typical effect size for an interactive-engagement course was found 1.7 to 2.3 while the effect size for a traditional course was about 0.5.

Results

The results of the research were examined in two groups which are Conceptual Survey of Electricity and Magnetism and Interactivity Instrument.

The Results Of The Conceptual Survey Of Electricity And Magnetism

The results (CSEM' s pre-test, post-test, and fractional gain, effect size, and student's t-test) obtained from the research were compared to determine the difference on conceptual learning of the experimental and control group.

According to Table 1, it was found that the fractional gain of the control group was low (0.29) while the fractional gain of the experimental group was medium (0.54). It can be concluded that the clicker format improves student's conceptual learning which is in agreement with Hake's data (1998).

Table 1

The Analysis Results of the Experimental and Control Group

Group	Pre-Test	Post-Test	Fractional Gain	Effect Size	t-value
Experimental Group	37.3	71.7	0.54	2.63	42.05
Control Group	36.7	55.6	0.29	0.48	15.28

t_{cv}=1.684; p(<0.05); The evaluation of the CSEM is made out of 100 points.

The fractional gain for students was calculated using the average of the pre-test and post-test for the groups. For two reasons, the author chose to calculate average gain in this manner, rather than to average the individual student gains. First, it allowed us to keep students who achieved a 100% correct score on the pre-test in the study. Individual gains cannot be calculated for such students, and so they cannot be included in the investigation if one chooses to calculate the average of individual gains. Second, calculating the average in this way reduces the skewing which occurs when students who pre-test with quite high scores then post-test with somewhat lower scores.

The effect size for the control group was medium (0.48) while the effect size of the experimental group was large (2.63). This result is close to the effect sizes determined from Hake's data (1998). Also the students' t-test was calculated to make two different comparisons. The first comparison was to determine if there was a significant difference between the pre-test and post-test scores. For this comparison, SPSS (Statistical Package for the Social Sciences) Base 16.0 statistical package was used. For the control group, students' t test (t) value was 15.28. For the experimental group, t value was 42.05. Both results were significant. This indicates that, even in the control group, significant gains were obtained. But, the difference of the experimental group was higher than that of the control group.

The results of the Interactivity Instrument

To evaluate the effect of using the clicker and flashcards on interactivity in the lecture, interactivity before and after the implementation of the clicker and flashcards were assessed. The descriptive statistics indicate that the interactivity at both the individual and class levels increased after using the clicker and flashcards.

Before the implementation of the clicker, the average level of interactivity at the individual level was 5.2, and that for the overall class interactivity was 5.4. After using the clicker, the average level of interactivity at the individual level was increased to 7.3, and that of the overall class interactivity was increased to 7.5. Alike, before the implementation of the flashcards, the average level of interactivity at the individual level was 5.1, and that for the overall class interactivity was 5.2. After using the flashcards, the average level of interactivity at the individual level was increased to 7.0, and that of the overall class interactivity was increased to 7.1.

A paired sample student's t-test was run to test for statistical significance. For interactivity at the individual (clicker), the statistics show that interactivity has been increased significantly ($t=5.70$, $p<0.05$). For overall class interactivity, the increase was also statistically significant ($t=6.50$, $p<0.05$). In the same way as for flashcards at the individual, the statistics show that interactivity has been increased significantly ($t=5.02$, $p<0.05$). For overall class interactivity, the increase was also statistically significant ($t=4.96$, $p<0.05$). The results of the student's t-test indicate that the clicker and flashcards significantly increase interactivity at both the individual and class levels.

Discussion

In this study, the CSEM (Conceptual Survey of Electricity and Magnetism) test was given for investigating students' conceptual learning achievement. When the results of the research were examined, the students' increase in conceptual learning was included in the experimental group and found higher than the achievement of the students included in the control group. The student's t test results for both groups were compared and the difference between pre-test and post-test results for both groups was meaningful. The difference on conceptual learning was found higher in favor of the experimental group. This result of the research showed the similarity with Hake (1998), Mazur (1997), and Reay et al. (2008)'s result. Therefore it can be said that combining the Peer Instruction (PI) approach with the clicker was effective on conceptual learning.

Also, the findings clearly demonstrated that the clicker and flashcards can effectively enhance interactivity in the lectures. Incorporating the clicker and flashcards in the lecture with the help of the Peer Instruction enables students to participate more in the lecture, provide opinions to questions from the lecturer, and receive feedback from the lecturer during the lecture regarding their understanding of the course materials, and gauge whether they are following the course materials with respect to the other students in the lecture. In other words, students are more engaged, more attentive, and more involved in the lecture.

Conclusions

In this research, it was found that the use of the clicker was effective on conceptual learning of the students. Also, the results showed that the classroom response system and flashcards can significantly improve interactivity in the lecture. The author reports that students are attracted to the CRS system because it promotes active learning in a large/small-class environment. When combined with Peer Instruction, students became involved in the teaching process. They were eager to discuss possible answers with each other as well as with the lecturer. Also, when the clickers are evaluated as a whole, it can be concluded that clickers offer a powerful and flexible tool for teaching and learning. Clickers can be used in various subjects with students of almost any level of academic training.

Future research could expand the author's findings by examining the impact of CRS in different disciplines or using different types of questions beyond the multiple-choice questions. Alternatively, researchers may also consider the impact of other technologies that can provide immediate feedback. For examples, cell phone technology is nearly ubiquitous, easy to use, and inexpensive. This technology, like the CRSs, offers users the ability to participate in polling activities. Future research endeavors could help determine if one system is more advantageous than the other. Based on the findings from this research, CRS offers such an opportunity for educators to adapt to the changing learning environment.

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Öğrencilerin Öğrenmesi ve Sınıf Etkileşimini Geliştirmek üzere Soru Cevap Sistemlerinin Kullanımı

Özet

Problem Durumu

Fen eğitiminde problemleri çözmek ve konuları anlamak için kavramları öğrenmenin önemi büyüktür. Öğrenciler bir konunun temelini kavramsal düzeyde öğrenmeye başlayarak daha sonra kavramlara yönelik problemleri çözmeye başlamalıdır. Fakat günümüzde yapılan araştırmaların çoğu öğrencilerin temel kavramları anlamadan problem çözmeye yöneldiklerini göstermektedir. Aslında bu durum geleneksel öğretim yöntemlerinin kavramsal öğrenmede istenildiği kadar etkili olmadığını vurgulamaktadır. Bu araştırmada ise öğrencilerin kavramsal öğrenmesine katkı sağlayacak bir eğitim teknolojisinden yararlanılmıştır. Bu eğitim teknolojisi çeşitli ülkelerde "Clicker" olarak anılmaktadır. Son yıllarda Amerika ve Avrupa' da kullanımı yaygınlaşan Soru Cevaplama Sistemleri (Classroom Response Systems "CRS") genellikle eğitim ve öğretimde sınıf içerisindeki öğretmen-öğrenci iletişimini arttırmaya yönelik kullanılmaktadır. Soru Cevaplama Sistemleri (SCS), öğrencilere yöneltilen kavramsal sorulara verilen cevapların istatistiksel açıdan değerlendirilerek zaman kaybetmeksizin ders esnasında öğrencilere geri dönüt verilmesini sağlamaktadır. Bu sayede sistem, öğrencilerin ders başında, sonunda ve esnasında kavramları öğrenmesine yardımcı olmaktadır. Bu çalışmada ise bu teknolojinin kullanımı akran öğretimi yöntemiyle daha da etkin hale getirilmiştir.

Araştırmanın Amacı

Bu çalışmada, Soru Cevaplama Sisteminin (SCS) öğrencilerin kavram öğrenme başarısı ve öğrencilerin bireysel ve sınıf etkileşimi üzerindeki etkisi amaçlanmıştır.

Araştırmanın Yöntemi

Araştırmada yarı deneysel yöntem (quasi-experimental design) kullanılmıştır. Araştırma iki grup üzerinden bir dönem boyunca Dokuz Eylül Üniversitesinde yürütülmüştür. Kavram öğretimi sırasında fizik derssinde öğrencilere yöneltilen kavram soruların cevaplanması ve cevapların gösterilmesi için kontrol grubunda yer alan öğrenciler renkli kartlar (flashcard), deney grubunda yer alan öğrenciler ise Clicker kullanmıştır. Her iki grubunun öğretimi de Akran Öğretimi (Peer Instruction) yöntemiyle yapılmıştır.

Akran Öğretimi öğrenci merkezli bir öğretim yaklaşımıdır. Bu öğretim yaklaşımının temelleri Harvard Üniversitesi'nde çalışan bir fizik profesörü tarafından ortaya atılmıştır. Bu öğretim yaklaşımı bilim dünyasında çok sayıda kabul görmüştür. Akran öğretimiyle öğretilen ders bir dizi kısa sunumlara ayrılır. Her sunumun merkezinde bir kavrama yer verilir ve her bir kavrama ilişkin kavram testi/testleri hazırlanır. Öğretici kişi/ler kavrama ilişkin kısa bir sunum yaptıktan sonra öğrencilerine hazırlanan kavram testini yöneltir. Öğrencilere kavram testini düşünmeleri için 2-3 dakikalık bir süre tanır. Bu süre içerisinde öğrenciler

yanlarındaki kişi/kişilerle kavram sorusuna ilişkin tartışmalara başlar. Süre bitiminde ise oylama yapılır. İstatistiksel sonuçları almak ve veri kaybını en aza indirmek için bu oylama genellikle clicker'lar yardımıyla yapılır. Eğer bu teknolojiye sahip değilsek renkli kartlar ya da el kaldırılarak da oylama yapılabilir. Eğer oylama sonuçları %30'un altında ise öğretici kişi kavrama ilişkin bilgi vermeye devam eder. Oylama sonuçları %30 ile %80 arasında ise öğrencilerine ikinci bir oylama için ek bir süre tanır. Bu zaman içerisinde öğrenciler konu hakkında tartışmalar sürdürürlür. Eğer oylama sonuçları %80 nin üzerinde ise yapılan kavram yanılgıları düzeltilerek yeni bir kavrama geçilir. Bir ders saati içerisinde 3 ile 5 arasında değişen kavram testine yer verilir.

Araştırmada öğrencilerin kavram öğrenme başarısı ve sınıftaki etkileşim düzeyleri iki ölçme aracı ile ölçülmüştür. Öğrencilerin kavram başarısı "Elektrik ve Manyetizma Kavramsal Ölçeği-Conceptual Survey of Electricity and Magnetism" ile öğrencilerin sınıftaki etkileşimi "Etkileşim Ölçeği-Interactivity Instrument" ile ölçülmüştür. Her iki grubun öğretimi aynı öğretim görevlisi tarafından ve aynı öğretim materyalleri kullanılarak yapılmıştır. Araştırmada kullanılan ölçme araçları öğrencilere uygulama öncesinde ve sonrasında verilmiştir. Araştırmadan elde edilen bulgular da istatistiksel olarak değerlendirilmiştir.

Araştırmanın Bulguları

Araştırmanın sonuçları iki grupta incelenmiştir. Deney ve kontrol gruplarında yer alan öğrencilerin kavramsal öğrenme düzeyinde oluşan farkı değerlendirebilmek için birkaç istatistiksel işlem (kesirli kazanım "fractional gain", etki büyüklüğü "effect size", ve t-testi) yapılmıştır. Yapılan istatistiksel işlemler sonucunda, deney grubunda (0.54) yer alan öğrencilerin kesirli kazanım oranı kontrol grubuna (0.29) göre daha yüksek bulunmuştur. Ayrıca deney grubunun etki büyüklüğü 2.63 "büyük" iken kontrol grubunun etki değeri 0.48 "orta" olarak bulunmuştur. Bu işlemlerin son basamağında ise t-testi yapılmıştır. Deney ve kontrol gruplarının ön ve son ölçümleri (kavram ölçeği için) karşılaştırıldığı zaman son ölçüm sonuçlarının yüksek olduğu ve aralarındaki farkın da anlamlı çıktığı bulunmuştur ($p<0.05$). Her iki grubun sonucu anlamlı olmasına rağmen deney grubunun kavramsal öğrenme başarı ortalaması kontrol grubuna göre daha yüksek çıkmıştır. Araştırmanın diğer sonucuna ise Etkileşim Ölçeğinden elde edilen verilerden ulaşılmıştır. Bu ölçek yardımıyla öğrencilerin bireysel ve sınıf düzeyindeki etkileşimleri ayrı ayrı iki alt ölçekte incelenmiştir. Her iki grubunun sonuçları değerlendirildiği zaman gerek clicker'in kullanıldığı deney grubundaki öğrencilerin etkileşimi gerekse renkli kartların "flashcard" kullanıldığı kontrol grubundaki öğrencilerin birey ve sınıf bazında etkileşim düzeylerinin pozitif (olumlu) yönde bir artış gösterdiği bulunmuştur.

Araştırmanın Sonuçları ve Önerileri

Araştırmanın sonuçları na göre deney grubundaki öğrencilerin kavramsal öğrenmedeki başarı seviyesi kontrol grubundaki öğrencilerin başarı seviyesinden daha yüksek olduğu ortaya çıkmıştır. Ayrıca, deney ve kontrol gruplarında yer alan öğrencilerin, birey ve sınıf bazındaki etkileşim seviyesinde pozitif bir artış olduğu görülmüştür. Derslerde clicker ve renkli kartların kullanımı bu sonucu olumlu yönde katkı sağlamıştır. Sınıfta clicker ya da renkli kartlarının kullanılması aslında tüm öğrencilerin aktif bir şekilde derse katılmasına da sağlamıştır. Bu katılımın sonucunda da aktif bir öğrenme ortamı yaratılmıştır.

Bu teknoloji, Amerika ve Avrupa da yaygın bir şekilde birçok eğitim kurumlarında kullanılmaktadır. Türkiye de ise bu teknolojinin eğitim kurumlarında uygulamaları görülmemektedir. Ülkemizdeki bilim insanları tarafından gerek fizik gerekse diğer bilim dallarında kavram yanılgıları üzerine çok sayıda araştırmaların yapıldığı bilinmektedir. Clicker teknolojisi yardımıyla ve derslere uygun seçilecek bir öğretim yaklaşımıyla ülkemizde karşılaşılan bu tür problemlere bir çözüm önerisi getirilmiş olabilir.

Anahtar Sözcükler: Akran öğretimi, clicker, eğitim teknolojisi, kavram öğrenme, soru cevaplama sistemi