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# Effects of Simulation Based Cooperative Learning on Physics Achievement, Science Process Skills, Attitudes Towards Physics and Usage of Interactive Whiteboards

# Simulasyon Destekli İşbirliğine Dayalı Öğrenme Yönteminin Fizik Başarısına, Bilimsel Süreç Becerilerine, Fizik ve Akıllı Tahta Kullanımına Yönelik Tutumlara Etkileri

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## Özet

*Bu çalışmanın amacı simülasyon destekli işbirliğine dayalı öğrenme yönteminin öğrencilerin fizik başarıları, bilimsel süreç becerileri, fizik ve akıllı tahta kullanımına yönelik tutumları üzerindeki etkilerini ortaya çıkarmaktır. Deney grubundaki öğrencilerle (N=25) elektrik konusunda simülasyonların entegre edildiği 'Öğrenci Takımları Başarı Bölümleri' tekniği, kontrol grubunda (N=24) ise simülasyonlarla desteklenmiş geleneksel öğretim yöntemi kullanılmıştır. Öğrencilerin cevapları t-testi ve içerik analizi ile değerlendirilmiştir. Çalışmanın bulgularında lise öğrencilerinin simulasyon destekli işbirlikli ortamlarda (Cohen's d=1.86) elde ettikleri başarı puanlarının sadece simulasyon kullanılan geleneksel öğrenme ortamlarına (Cohen's d=1.09) göre daha yüksek etki büyüklüğüne sahip olduğu, bu iki yöntem arasında öğrencilerin bilimsel süreç becerilerinde, fizik dersine ve akıllı tahta kullanımlarına yönelik tutumlarında anlamlı farklılık olmadığı görülmüştür. Sonuç olarak, simülasyon destekli işbirliğine dayalı öğrenme yönteminin öğrencilerin fizik başarılarını geleneksel yönteme göre olumlu yönde daha fazla etkilediği, her iki yöntemin de öğrencilerin bilimsel süreç becerilerinde, fizik ve akıllı tahta kullanımına yönelik tutumlarında küçük bir etki yarattığı ortaya çıkmıştır.*

***Anahtar Kelimeler:*** *Simülasyon Destekli Öğrenme, İşbirliğine Dayalı Öğrenme, Fizik Eğitimi*

## Abstract

*The aim of this study is to investigate the effects of simulation based cooperative learning on students' physics achievements, science process skills, attitudes towards physics and interactive whiteboards. In experimental group (n=24), while students taught with Student Teams Achievement Division (STAD) method with the integration of simulations in electricity subject, in control group (n=25), traditional learning supported by simulations. Students' responses were analyzed by using t-test and content analysis. In the findings of the study high school students in simulation based cooperative learning environments (Cohen's d=1.86) have higher effect size than in traditional learning environments supported with simulations, between these two methods there were no statistically significant difference on students' science process skills, attitude towards physics lesson and usage of interactive whiteboards. As a conclusion, simulation based cooperative learning positively affected students' physics achievements more than traditional learning and both techniques made small differences on students' science process skills, attitudes towards physics and usage of interactive whiteboards.*

***Keywords:*** *Simulation Based Learning, Cooperative Learning, Physics Education*

## 1. Introduction

As digital technologies became pervasive and students became more teach-savvy, there was an increase in pressure to bring educational technologies into classrooms (Smetana & Bell, 2012). It was claimed by technology advocates that computer technologies could transform learning by providing teachers with more opportunities offered and students with more collaboration with peers and experts as well as with increasing access to information, ideas expressed and communicated and difficult topics explored (Sivin-Kachala & Bialo, 2000; Songer, 2007). However, educational technologies were poorly integrated into classrooms (Songer, 2007), or used in a limited way.

Bitner and Bitner (2002) described eight keys to success of integrating technology into classrooms, one of which was teaching models, and they stated that different kinds of programs could be used in large and small group instruction to facilitate teaching and learning. Computer simulations, which are dynamic, interactive and easily usable programs, support student-centered and inquiry-based teaching models (Smetana & Bell, 2012) and advocate the idea of Bitner and Bitner related to large and small group instructions. Smetana and Bell also claimed that simulations were effective tools when they were integrated with other forms of instruction and that they should be used as a supplement to, rather than substitute for, other learning activities. Connecting the use of simulations to inquiry learning is particularly suitable because they contain a model of a system or process which allows the learner to explore the phenomena by manipulating input variables and observing the changes (Eysink, de Jong, Berthold, Kolloffel, Opfermann & Wouters, 2009).

The applications of computer simulations have a special interest in physics education because they can support powerful modeling environments involving physics concepts and processes (Jimoyiannis & Komis, 2001). Interactive simulations give an opportunity to the users to adjust each of the parameters involved in the phenomenon depicted (National Research Council, 2011) and improve students' comprehension of physical phenomena, especially of the most abstract ones (Romero & Martinez, 2012) as computer simulations have the potential to supplement to, rather than substitute for, make instruction more interactive and make learning abstract concepts more concrete (Ramasundarm, Grunwald, Mangeot, Comerford, & Bliss, 2005). Moreover, simulations enable making and observing of experiments, and in many cases learners visualize features that often, by their nature, remain invisible (Kukkonen, Kärkkäinen, Dillon, & Keinonen, 2014).

Interactive whiteboards, which are another digital technology adopted into classroom environments, have been frequently used

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in Turkish high schools as part of the FATİH project (Aytaç, 2013) (Movement of Enhancing Opportunities and Improving Technology). One of the main earnings of these boards is to give a chance to use computer simulations in classroom environments because interactive whiteboard has components such as computer, projector and board as well as an interactive touch pen and a panel with an active surface using a combination of software (Tosuntas, Karadag & Orhan, 2015). Hennessy et. al. (2007) states that the use computer simulation in interactive white boards has focused on the design of pedagogical principles such as predict, observe, explain, explore and check.

The integration of technology into classrooms with the use of interactive whiteboards and computer simulations would create a difference on students' conceptual understandings (Jaakkola, Nurmi & Veermans, 2011), attitudes (Christensen, 2002) and science process skills (Huppert, Lomask & Lazarowitz, 2002). With the start of FATIH project in Turkey, researchers began to study the effects of interactive white boards and computer simulations on the mentioned dependent variables. For example, in a quasi experimental study, Sarı and Güven (2013) searched the effect of inquiry based learning with the activities (simulations, animations and videos) of interactive whiteboards on students' academic achievements and motivations. The findings of the study indicated that students that used interactive whiteboards and activities showed a higher performance than traditional group students with medium effect size. In another study, Çelik and Gündüz (2015) found the effect of interactive whiteboards on students' attitudes towards the use of interactive whiteboards. Moreover, in another study, in which 181 teachers and 918 students from pilot schools of FATIH project participated, (Pamuk, Çakır, Ergun, Yılmaz & Ayaş, 2013), most of the teachers and students were positive in general about the having access to interactive whiteboards in their schools and classrooms.

So, FATIH project gave a big chance to teachers and students about the use of computer simulations and interactive whiteboards. However, as regards the statement of Smetana and Bell (2012) stated before, these technologies should be used as a supplement to, rather than substitute for, and Yelon (2006) stated that while using technology in classrooms, it may not be as beneficial as expected because technology and teaching method should be successfully blended to create an effective way of teaching. This idea also brings Clark's (1994) opinion to mind, saying "learning is influenced more by the content and instructional method than type of medium". Cooperative learning is an important methodological strategy to develop students' competencies (Palomares & Chisvert, 2016). Technology can also be adapted to cooperative learning to enhance students' comprehension and academic achievements (Tlhoaele, Suhre & Hofman, 2016).

In the literature, there are some studies combining simulation and cooperative learning (Eun & Young, 2017; Chen, Hua, & Ge, 2014; Phillips & Graeff, 2014; Karacop & Doymuş, 2013). Eun and Youn (2017) states that when simulations are combined with cooperative learning students communication skils, academic performances, team efficacy and performance scores were improved. Additionally they recommended that this combined method should be applied in educational sessions to enhance educational outcomes. Similarly, Chen, Hua, and Ge (2014) claims that simulations and cooperative learning provide effectiveness and advantages in classroom environment. In another study, Phillips and Graeff (2014) states that these activities make an improvement in students' attitudes, confidence and understanding of concepts. Lastly, Karacop and Doymuş (2013) found that in a chemical bonding subject using a cooperative learning and simulations together was more effective than traditional teaching method. As a result of these studies, it was seem that teaching a subject with simulations and cooperative learning brings out their advantages particularly.

The aim of this study was to find out the effects of simulation based cooperative learning on high school students' physics achievements, science process skills and attitudes towards physics and the use of interactive whiteboards.

## 2. Method

### Experimental Design and Sampling

A quasi-experimental design "Pre-test and post-test with control group design" was used in the study. Of the groups in the study, the experimental group was taught using simulation based cooperative learning method, while the control group was taught using simulation based traditional learning method. At the end of the implementation, open-ended questions were used to obtain the participants' views on simulations, interactive whiteboards and teaching methods.

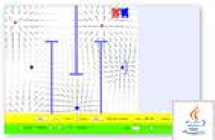
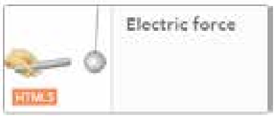
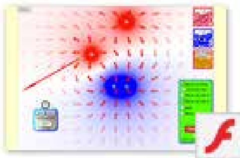
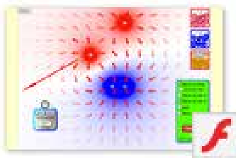
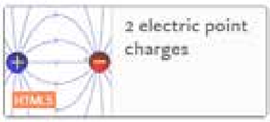
Convenient sampling procedure was applied for the study. A school near to the researchers university was selected and the study was implemented in two classes of this school. Participants of this study were high school physics students (n=49) from 11$^{th}$ grade class. The students were at the ages of 16-17. The interactive whiteboards were using for three years in this school and these boards were supplied in the FATIH project. Two intact classes were randomly assigned to simulation based cooperative (n=24 ; 12 boys and 12 girls) and simulation based traditional (n=25; 12 boys and 13 girls) teaching environments. There were 25 students in simulation based cooperative learning group during the implementation, however, one student did not take post-tests, so this student was taken out during the data analysis process.

The lessons were given by a physics teacher who was assisted and supervised by the researcher of this study. The lessons were also observed by a pre-service science teacher to control how much the given procedure was applied by the teacher. Two science educators/researchers from a Turkish university contributed to the designing of the lesson plans of simulation based cooperative and simulation based traditional teaching methods.

**Instructional Intervention**

The unit "electricity" (electric force, field and potential of point charges) for 11th grade students was developed by physics teacher, researcher and two science educators/researchers through steps of 5E learning cycle; engage, explore, explain, elaborate and evaluate. This cycle is a widely used inquiry based method for science instruction providing a structured way to implement inquiry in the classroom (Marek, 2008). In engage, explore and elaborate phases, PHET and eduMedia simulations were used. Phet simulations, which were constructed by Colorado University, allow students to probe and explore physical phenomena and these simulations are engaging tools for student learning (Podolefsky, Adams, Lancaster & Perkins, 2010). eduMedia simulations, which were constructed by a private company, include more than 800 simulations, most of which are appropriate for Turkish high school curriculum. These simulations was evaluated in the FATIH project by Electronic Knowledge Network (EBA) and found appropriate and effective. All eduMedia simulations was used in public schools for three years. Table 1 shows the simulations used during instruction with the corresponding 5E learning cycle phases and related web addresses.

**Table 1. Simulations Used During Instruction**

| | Electric Force | Electric Field | Electric Potential |
|---|---|---|---|
| Engage |  Electric Field Hockey http://phet.colorado.edu/en/simulation/legacy/electric-hockey |  https://www.edumedia-sciences.com/tr/media/63-electric-force |  https://www.edumedia-sciences.com/en/media/182-field-force-potential |
| Explore |  https://www.edumedia-sciences.com/tr/media/89-coulomb-yasas |  Charges and Fields http://phet.colorado.edu/en/simulation/legacy/charges-and-fields |  Charges and Fields http://phet.colorado.edu/en/simulation/legacy/charges-and-fields |
| Elaborate |  https://www.edumedia-sciences.com/tr/media/82-2-noktasal-elektrik-yuku |  https://www.edumedia-sciences.com/tr/media/409-superposition-principle |  https://www.edumedia-sciences.com/en/media/121-electric-field-and-potential |

**Simulation Based Cooperative Learning Group**

Student Teams Achievement Division (STAD) method, developed by R. Slavin in 1978, was used as a teaching method. In STAD, students are assigned to four – or five- member learning teams. The teams are composed of high, average and low performing students of boys and girls (Balkafih, 2003). While STAD is being implemented, (1) the teacher introduces new materials, (2) team members study worksheets, (3) individual quizzes are taken, (4) the teacher combines the scores to create team scores, and (5) members of the winning team are given certificates (Balkafih, 2003).

During the study, 5 groups were constructed with 25 students heterogeneously. The academic achievements and gender were used as criteria while constructing groups. The study took 3 weeks, 12 hours. At the beginning of each week, the teacher introduced the simulations, and explained each step of 5E learning cycle that students would complete. For example, first week, the teams started with "electric field hockey" simulation, then explored Coulomb's law by using "Coulomb's Law" simulation, explained the Coulomb's law and filled the worksheets including problems related to electric forces, then used "2 electric point charges" for elaboration and finally had a test related to electric forces in the evaluation part. Teacher collected the tests to determine the winning team and each member of this team was rewarded with a cinema ticket. After first week, the same order was applied by the teacher, and students' performance was evaluated to determine the winning team by comparing new scores with the first score taken during the first week of evaluation test.

**Simulation Based Traditional Learning Group**

Although the cooperative teaching method is indirect and student-centered, traditional method is direct and teacher centered meaning teacher lectures, provides notes and solves sample examples (Martin, 2006).

The study took 3 weeks, 12 hours. During the study, the teacher lectured by using the simulations applied among the cooperative learning group. First, the teacher introduced "electric field hockey" simulation and let some students play with it on interactive whiteboard. Secondly, he showed "Coulomb's Law" simulation and explained Coulomb's Law. Thirdly, he used "2 electric point charges" simulation, and finally he solved problems that were used in the evaluation part of cooperative group. Each week, the same order was applied by the teacher. Students were not evaluated each week.

**Instruments**

Electricity achievement test (EAT), science process skills test (SPST), physics attitude scale (PAS) and use of interactive whiteboards attitude scale tests (IWAS) were administered as pre-tests and post-tests.

Electricity Achievement Test was constructed by the researcher and the teacher. First of all, all university entrance exam questions related to electricity was selected from ordinary books. Then some of them was eliminated by thinking difficulty levels and relevance to teaching programme. 20 items test was constructed and then EAT was send to another high school teacher and another academician. EAT item number decreased to 15 according to their opinions. Finally EAT, which consists of 15 items, was implemented to understand high school students academic achievements about electric force, field and potential. EAT was scored with 1.0 for correct answers and 0.0 for wrong answers.. Higher scores of the students indicated more understanding of the electricity concept while lower scores indicated less. However after implementing EAT as pre-test and post-test, 5 items were deleted to increase the reliability coefficient of the test. Finally 10 items were used to analyze the students' electricity achievements. In this final version of EAT, the reliability coefficient was found as 0.58 and 0.66 for pre-test and post-test respectively.

SPST, originally developed by Temiz (2007), was used in this study by the way of Çetin (2013). This test consisted of totally 20 items, two of which were essay types and eighteen of which were multiple choice types. It includes 5 dimensions; (1) identifying and defining variables and formulating hypothesis, (2) describing relationships between variables, designing investigations and experimenting, (3) organizing data in tables, (4) organizing data in graphs, (5) analyzing investigations and their data. The scores of the students were ranged between 0.0 and 40.0 by giving maximum 8 points to each dimension. The reliability coefficients were found as 0.85 and 0.91 for pre-test and post-test respectively. In this study these values were found as 0.80 and 0.76 respectively.

PAS, developed by Taşlıdere (2007), were used to identify students' attitudes towards physics. This scale consisted of 24 items with five-point Likert type. Thus, the scores were ranged between 24.0 and 120.0. The higher scores the participant got, the higher the students' attitudes towards physics were. The reliability coefficient was found as 0,90 and 0,92 for pre-test and post-test respectively.

IWAS, developed by Tataroğlu and Erduran (2010), were used to obtain students' attitudes towards the use of interactive whiteboards. This scale consisted of 22 items with five-point Likert type. The minimum score that could be taken from the test was 22.0 and the maximum was 110.0. Higher scores demonstrate the students have high attitudes towards the use of interactive whiteboards. The reliability coefficient was found as 0,93 and 0,89 for pre-test and post-test respectively.

Additionally, four open-ended questions were asked to understand students' views on simulations, interactive white boards and teaching methods at the end of the study in two groups. These questions were developed by two researchers that are working in the field of science education. An interview form was prepared by using these questions and forms were implemented as an in-class activity in both groups. Open-ended questions were distributed to whole-classes in one classroom hour and it took approximately 20 minutes to complete all questions by students. The aim of asking these questions was only obtain students' general opinions about the study and interactive whiteboards. So, only content validity of the questions was supplied by two researchers.

**Data Analysis**

The data were evaluated in statistical program (SPSS 21.0). The mean, standard deviation and Cohen's d values, which students got from pre-tests and post-tests, were presented descriptively. Then t-test (independent sample t-test and paired samples t-test) analyses were used to determine if there was a significant difference between the groups. Finally, the content analysis was conducted to find out the participants' views on simulations, interactive whiteboards and teaching methods.

## 3. Results

Descriptive statistical analysis (mean scores and standard deviations for pre-test and post-test scores) and t-test results for each dependent variable are presented.

**Descriptive Statistical Analysis**

The mean scores, standard deviations and Cohen's d values for pre-test and post-test results of experimental (simulation based cooperative learning group (SBCL)) and control (simulation based traditional learning group(SBTL)) groups are demonstrated in Table 2.

**Table 2. Descriptive Statistic For Pre-Test and Post-Test Results of Experimental and Control Groups**

| | | n | Pre-Test | | Post-Test | | Cohen's d |
|---|---|---|---|---|---|---|---|
| | | | X | S | X | S | |
| EAT | SBTL | 25 | 2.40 | 1.96 | 4.56 | 1.98 | 1.09 |
| | SBCL | 24 | 1.90 | 1.41 | 4.90 | 1.79 | 1.86 |
| SPST | SBTL | 25 | 22.02 | 8.36 | 19.64 | 9.64 | -0.26 |
| | SBCL | 24 | 19.18 | 7.12 | 19.04 | 10.34 | -0.02 |
| PAS | SBTL | 25 | 88.82 | 11.39 | 87.09 | 13.77 | -0.14 |
| | SBCL | 24 | 90.57 | 15.70 | 84.51 | 16.88 | -0.37 |
| IWAS | SBTL | 25 | 71.07 | 14.77 | 71.04 | 13.77 | 0.00 |
| | SBCL | 24 | 73.64 | 20.74 | 71.51 | 16.38 | -0.11 |

According to Table 2, both teaching methods have large effect on students' achievements. Yet, the Cohen's d value for cooperative learning is higher than that of traditional one. The other variables have small effect sizes.

**T-test Results**

The statistically significant difference between experimental and control group was searched by using independent sample t-test for pre-test results to determine whether there was a significant difference between groups at the beginning of the study. The findings were demonstrated in Table 3.

**Table 3. Independent sample t-test results for pre-tests of EAT, SPST, PAS and IWAS**

| | t | df | Sig. | Mean Difference |
|---|---|---|---|---|
| EAT | 0.974 | 47 | 0.335 | 0.50 |
| SPST | 1.274 | 47 | 0.209 | 2.83 |
| PAS | -0.451 | 47 | 0.654 | 1.76 |
| IWAS | -0.499 | 47 | 0.620 | 2.56 |

According to Table 3, it was found that there was no significant difference on students' physics achievements, science process skills, attitudes towards physics and interactive whiteboards. Additionally, it was seen that the mean differences between experimental and control groups were very low. Independent sample t-test results for post-tests of EAT, SPST, PAS and IWAS were demonstrated in Table 4.

**Table 4. Independent sample t-test results for post-tests of EAT, SPST, PAS and IWAS**

| | t | df | Sig. | Mean Difference |
|---|---|---|---|---|
| EAT | -0.729 | 47 | 0.470 | 0.40 |
| SPST | 0.210 | 47 | 0.835 | 0.59 |
| PAS | 0.587 | 47 | 0.560 | 2.57 |
| IWAS | -0.111 | 47 | 0.912 | 0.46 |

According to Table 4, it was found that there was no statistically significant difference on participants' post-test scores of EAT. That means that applied learning methods did not create a difference on students' academic achievements. However, when the Cohen's d values are compared between groups, it was seen that when the simulations combined with cooperative learning caused more effect size than simulations used in traditional learning. Additionally, there was no statistically significant difference on the other dependent variables, SPST, PAS and IWAS.

Paired sample t-test was also used to determine if there was a statistically significant difference between the applied methods and dependent variables (EAT, SPST, PAS, IWAS). The results were demonstrated in Table 5.

**Table 5. Paired sample t-test results for EAT, SPST, PAS and IWAS**

| | | t | df | sig |
|---|---|---|---|---|
| SBTL | EAT | -7.425 | 24 | 0.000 |
| | SPST | 1.085 | 24 | 0.289 |
| | PAS | 0.730 | 24 | 0.472 |
| | IWAS | 0.010 | 24 | 0.992 |

| | | t | df | sig |
|---|---|---|---|---|
| SBCL | EAT | -3.973 | 23 | 0.001 |
| | SPST | 0.101 | 23 | 0.921 |
| | PAS | 1.736 | 23 | 0.096 |
| | IWAS | 0.680 | 23 | 0.503 |

According to Table 5, traditional and cooperative learning resulted with the statistically significant increase on students' academic achievements, but cooperative learning created more effect size than traditional learning group. None of the teaching methods created a statistically significant difference on the other dependent variables, SPST, PAS and IWAS.

**Interview Results**

Four open-ended questions, which were constructed by two researchers, were asked to all participants in a structured form. The results were summarized in Table 6.

**Table 6. The summaries of the responses to the given open-ended questions**

<table>
<tr><td colspan="2">1. Do you think the use of simulation based activities in class is helpful to your learning physics?</td></tr>
<tr><td>SBTL</td><td>SBCL</td></tr>
<tr><td>• 40 % of participants (n=10) answered "yes" and 60 % (n=15) answered "no".<br>• "Yes": Because I can understand and comprehend the subject easily.<br>• "No": Because simulations look like games and we played games on whiteboards and could not understand anything.</td><td>• 58 % of participants (n=14) answered "yes" and 42 % (n=10) answered "no".<br>• "Yes" : because we learn by doing and experiencing and they (simulations) are more funny and enhance retention.<br>• No: because I can understand the subject but I can't apply the rules or formulas during exams.</td></tr>
<tr><td colspan="2">2. Did your approach towards physics lesson changed by the way of teaching method used in your class?</td></tr>
<tr><td>SBTL</td><td>SBCL</td></tr>
<tr><td>• While 56 % (n = 14) claimed that their approach towards physics lesson affected negatively from the use of simulations in class, 16 % (n=4) stated that they enjoyed using simulations.<br>• 24 % (n=6) stated that their approach towards physics did not change with use of simulations.<br>• One student (4 %) did not answer this question.</td><td>• 84 % (n=20) of participants stated that the use of simulations in a group changed their approach towards physics in a positive way. They stated that the lesson became more understandable and funny; participation to class activities increased, besides, they started to love the lesson.<br>• 12 % (n = 3) stated that their approach did not change.<br>• One student (4 %) did not answer this question.</td></tr>
<tr><td colspan="2">3. Electricity unit topics were covered in your lessons by using interactive whiteboards. Do you think you understand these topics or not. How do you think your understanding was affected using interactive whiteboards?</td></tr>
<tr><td>SBTL</td><td>SBCL</td></tr>
<tr><td>• 56 % (n=14) of participants thought negative about interactive whiteboards. Participants believed that the class time was not appropriate for using these activities, had a difficulty while focusing on the topic and saw the simulations as a game on tablets.<br>• Other participants (44 %) stated that the use of interactive whiteboards did not affect their learning much.</td><td>• 58 % (n=14) of participants thought negative about using interactive whiteboards on physics lessons. These participants stated that they could understand much if classical board was used instead of interactive whiteboards.<br>• Only 17 % (n=4) stated that the use of interactive whiteboards enhanced retention and the subject become more concrete.<br>• 8 % (n=2) of participants stated that they understand the subject in average level.<br>• 17 % (n=4) did not answer this question</td></tr>
<tr><td colspan="2">4. How do you think the use of interactive whiteboards affect lesson, teacher and student?</td></tr>
<tr><td>SBTL</td><td>SBCL</td></tr>
<tr><td>• 56% (n=14) of participants thought negative about interactive whiteboards. They stated that these boards decrease the interaction between teacher and student.<br>• 44 % (n=10) thought that although these boards had some advantages like the visuality and effective use of class time, classic boards should be preferred.</td><td>• Most of the participants (84%, n=20) thought positive saying interactive whiteboards supply some facilities to teachers and students, and the lesson becomes more efficient. Interactive whiteboards save class time and facilitates learning.<br>• Only 4 % (n=1) stated negative opinion about interactive whiteboards and claim that interactive whiteboards made him sleepy and hurts his eyes.<br>• Others 12 % (n=3) did not answer this question.</td></tr>
</table>

## 4. Conclusıon and Discussion

This study was conducted with the aim of investigating the effects of the simulation based cooperative learning approach in 11th grade physics lesson in the electric subject on students' academic achievements, science process skills, attitudes towards physics and interactive whiteboards. First, the research determined that students in the experimental group who were taught with simulation based cooperative learning had higher scores on achievement test than students in the control group that were taught with simulation based traditional learning approach. This result was not statistically significant, however the effect size of experimental group was higher than the control group. On the other hand there are some researches in the literature, that found significant difference when cooperative learning was applied (Newmann & Thompson , 1987; Vaughan, 2002; Parveen, 2012). Capar and Tarim (2015) designed a meta-analysis study to determine the effects sizes for cooperative learning and reported that the effect size for high schools was 0.54. However, this study found the effect size as 1.86 for simulation based cooperative learning and 1.09 for simulation based traditional learning. That shows that both approaches have a positive effect on students' achievements but the reason of the difference between the effect sizes may be caused from the integration of simulations into cooperative learning. Sarı and Güven (2013) searched the effect of inquiry based learning with simulations, animations and videos on prospective teachers' academic achievements and compared this method with traditional learning. They found that the use of these kinds of activities with interactive whiteboards caused the medium effect size on students' academic achievements. When their effect size value converted to Cohen's d, it was 0.57. Additionally, Huppert, Lomask and Lazarowitz' (2002) study claim that when simulations were used in traditional learning, the effect size became 1.14. Similar to these study findings, this present study also found the effect size as 1.09 and it is obvious that when the technology and teaching method are successfully blended, the effect size increases. So, it can be concluded that when simulations were combined with cooperative learning students' academic achievements could increase much.

The second finding of this study indicated that students in control group had lower scores on science process skills test than their own pre-test scores. However, in experimental group, students' scores did not change between pre-test and post-test. The decrease in control group was not found as statistically significant. The reason of that decrease may be explained by using the responses of students to open-ended questions. Students claimed that the use of simulations in a traditional way did not affect their understanding and they saw the simulations as games. Huppert, Lomask and Lazarowitz (2002) claimed that the use of computer simulations requires logical thinking skills. So during the study, if the students see the simulations as games or believe they do not affect their understandings, obviously their science process skills could not change. Additionally development of these skills need long-time and long-step processes, the study took just three weeks and students' science process skills did not change. If the implementation time is getting longer, it may be resulted with the increase in science process skills.

The third finding of this study indicated that when the effect of simulation based cooperative learning on attitudes towards physics and interactive whiteboards was taken into consideration, it was seen that the general effect sizes were low, -0.37 and -0.11 respectively. In addition to that, the differences about the attitudes were not statistically significant. The reason of this low effect size may be the duration of the study, again. According to Capar and Tarim (2013), the study implemented for 5 weeks may not be sufficient to change the attitudes of students. The implementation of this study took 3 weeks, less than the study of Capar and Tarim, so this duration can be considered to be relatively short. In another study, the attitude change was not observed during simulation based learning study, too (Shaw & Okey, April 15-18,1985); And it also claims that the duration time of the study should be more to create a significant change on students' attitudes.

The final finding of this study indicated that when the responses of participants to open-ended questions were evaluated, most of the students in control group saw the simulations as games and most of the students in experimental group saw the simulations as helpful activities. The use of simulations in a cooperative learning created a difference on students' views about the simulations. Similarly, the use of cooperative learning affected students' approaches towards physics but these were not found statistically. 80 % of the students claimed that their approaches towards physics changed positively with implementation of the study in experimental group, 56 % of those of control group changed negatively. Lastly, while most students in experimental group believed that the use of interactive whiteboards facilitates teaching and learning and enhances retention, in control group students believe that interactive whiteboards decrease the interaction between teacher and student in class. Again, the effect of cooperative application was seen, because there was an obvious difference on students' ideas about simulations, interactive whiteboards and approaches towards physics.

As a conclusion, the findings of this study demonstrated that if simulations were effectively integrated with cooperative learning, high school students' achievements would increase, and students' ideas about interactive whiteboards and physics lesson would change in time. As a recommendation, simulations could be integrated into other cooperative learning strategies like teams-games-tournaments, Jigsaw, learning together and group investigation and they could also be tested by adopting into other teaching methods like problem based learning, active learning, 5E learning cycle. However, while integrating them, the effectiveness should not be forgotten.

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