Turhan Civelek a, Erdem Ucar a, Orhan Gokcol b

a Trakya University, Institute of Science Department of Computer Engineering, Box 22000 EDİRNE/TURKEY
b Bahcesehir University, Institute of Science Department of Information Technologies, Box 34353 ISTANBUL/TURKEY

Abstract

The main goal of this study is to present the significant difference between utilization of simulations of physics experiment during lectures and traditional physics lecture. Two groups of 115 students were selected for the purpose of the study. The same subjects have been taught to both groups, while a group of 115 had their lectures in science and technology class supported by physics experiment simulations for a month, the other group of 115 had their lectures in a traditional way. The research has been conducted in Izzet Unver high school in Istanbul, Gungoren. The main resource of this research is the data collected through surveys. The survey is a result of the literature and the suggestions of the experts on the topic. Thirty questions were prepared under ten topics. Two different surveys were conducted during the data collection. While the first survey questions focused on the effects of traditional lecturing on students, the second survey questions were targeting the effects of lecturing via the support of physics experiment simulations. The data collected as a result of the survey which was coded in to SPSS Software and statistical analyses was conducted. In order to test the significant difference between the means t-test was utilized. 0.05 was chosen as the significance level. As a result of the analyses utilized, significant differences were found in their satisfaction on class materials, in their motivation, in their learning speed, in their interest in the class, and in their contribution to the class. In findings such as the effect on students’ learning, information availability, organization of information, students’ integration to the class and gaining different point of views “lectures supported by physics experiment simulations” is significantly different from traditional lecturing. As the result of the literature review and the statistical analyses, “lectures supported via physics experiment simulations” seem to be more effective than traditional lecturing in science classes, in issues such as variability of approaches, student concept delusions, laboratory applications, utilization of information technologies and simulations. © 2012 Published by Elsevier Ltd.

Keywords: Physics course delivery using computer simulations, Physics teaching, computer assisted teaching.

1. Introduction

Learning is taking its shape according to the mental structure, prior knowledge related to the subject, and the perception of the environment (Korkmaz, 2004). Information is composed effectively by interacting with the social environment and by using prior knowledge (Demirel, 2006). The individual starts to think about the problem, to

Turhan Civelek. Tel.: +90-532-364-5191
E-mail address: turhancivelek@trakya.edu.tr

1877-0428 © 2012 Published by Elsevier Ltd. Selection and/or peer review under responsibility of Prof. Dr. Hüseyin Uzunboylu
Open access under CC BY-NC-ND license, doi:10.1016/j.sbspro.2012.06.900
establish a hypothesis and to test this hypothesis according to this interaction. This process feeds the critical thinking and makes individuals active and motivated (Aydn, 2009).

The visual information is saved after less than second, kinesthetic information after 2 or 3 seconds and auditory information is saved after 4 seconds in brain. In tertiary memory, long time, strong connection networks can be created between information which are supported with visual contexts and materials (Keleș and Çepni, 2006). Stimulating different senses in virtual environments plays a supportive role in the perception of concepts and events (İlknur, 2009).

The introduction of the subjects should be related with real life and should be able to increase motivation. Verbal lectures, demonstration tests, animations, simulations and different and outstanding examples which are supported with visuals should be used during the presentation of the subjects (Köseoğlu and Kavak, 2001).

Today the number of students and the need for education are increasing rapidly. The amount of information is growing and becoming complex. Individual differences and abilities are becoming more and more important. For these reasons the necessity for using computers in education is gaining importance (Güzeller and Korkmaz, 2007).

Due to the abstract structure of Science education, it is known that some students have misconceptions in concepts related to science education (Gilbert, Watts and Osborne, 1982). For this reason students’ curiosity and desire to discover is negatively affected (Bozdemir, 2005).

The complicated information which is presented to students in physics education can be simplified by using information technologies and creates them opportunities to learn by doing (Ramsden, 2002). Life-threatening experiments are prepared with the help of simulations in computer environments. Simulations represent the natural world, scientific models and events that cannot be inferred through experiments. Thus, students’ effective learning is triggered by this way (Karamustafaoğlu, Aydn and Özmen, 2005).

More information is required on using technologies during the process of teaching and learning in schools (Hinton, 2006). Information technologies used in the classrooms provide teaching opportunities for teachers and fruitful experiences for students (Kao, 2009). Teachers are required to get prepared to these new technologies beforehand in order for schools to keep pace with computer technologies and integrate these technologies with the lessons (Miller, 2010).

Necessary precautions should be taken in order for students to use information technologies effectively in our rapidly developing age. Information technologies used in schools should provide new environments. Especially the variety of the studies which are carried out with computers should be increased (Üstünel, 2010).

In the researches it is seen that virtual laboratory applications increase students’ achievement more than traditional laboratory method. Carrying out lessons by using both traditional and virtual laboratory method is more effective for increasing students’ handicraft, graph drawing, and interpretation capabilities (Martin 2000).

Today’s studies focus on a sense of presence in virtual environments which were previously prepared and sensing these environments by touching. Sense of presence or elongation is to feel oneself in the world which is transmitted through a channel or to believe that you are in that transmitted world. In literature most of the studies related with virtual studies focus on the sense of presence which is described on the basis of equipments which are used instead of interaction concept (Hacer, 2007). A person is the one who perceives the real world by touching as well as being an agent. The person is connected to the real world by touching. The familiarity of the stimulus in touching depends on the prior experience and can change from person to person (Ballesteros and Heller, 2008).

2. Methods

A physics course was carried out for a month with the students who were selected for the research. In traditional lectures, electrification subject was explained to 9th grades, shots subject to intermediate grades and refraction of light subject to 11th grades on the black board through presentation in the classroom environment.

In the lectures with experiment simulations same subjects were covered by using a projection device in information and technology classroom by reflecting to the board in way that all students in the classroom could see. Each student used a computer which provides an interactive interaction and an access to experiment simulations over a local network for making practice right after lecturing.

The data resource of this research consisted of the data which was obtained by using surveys. The survey questions were generated by scanning previous researches in accordance with views of experts. Survey questions are five point likert type of scale. Two surveys were carried out at the end of the lecturing month for collecting data. As the first survey form consisted of questions including the effects of traditional lecturing on students, the second survey form consisted of questions including the effects of lecturing by using simulations on students.
Table 1: Example of Survey Questions related with Traditional Lecturing

<table>
<thead>
<tr>
<th>No</th>
<th>Survey Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Do you think the context and the materials used in the lesson sufficient?</td>
</tr>
<tr>
<td>2</td>
<td>Does it provide an access to some expensive document, image and information?</td>
</tr>
<tr>
<td>3</td>
<td>Does it allow you to see some materials that cannot be brought into classroom environment?</td>
</tr>
</tbody>
</table>

The data was analyzed statistically in the scope of this research. T-test was used in order to test the significant difference between mean scores. The significance level was determined as p<0.05 in statistical calculations.

The sample of this research consisted of students who were randomly selected from İzzet Ünver Secondary School. The distribution of students according to their gender and grades were shown in table 2.

Table 2: The Distributions of Students by Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>9th Grade</th>
<th>Intermediate Grade</th>
<th>11th Grade</th>
<th>Gender</th>
<th>9th Grades</th>
<th>Intermediate Grade</th>
<th>11th Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>60</td>
<td>33</td>
<td>22</td>
<td>Total</td>
<td>60</td>
<td>33</td>
<td>22</td>
</tr>
</tbody>
</table>

2.1. The Objectives Targeted From Using Simulations, Student Achievements and Patterns Of Use

In this research it was targeted to teach subjects of electrification, shots and refraction of light to students practically by using simulations which were prepared in virtual environment. The subjects of how the students will use simulations and how they can change parameters and as a result of changing these parameters which events can be observed were dealt with.

Electrification Simulation: In figure 1a, in the electrification simulation load flow occurs between materials brushed against each other and this load flow takes place with the movement of electrons. Same loads are pushing each other and opposite loads are pulling each other. As the loads are getting away from each other, the force between them is decreasing. Electrification is occurring with the effect.

Shots Simulation: In figure 1b, in the shots simulation; it is shown that the range is connected with the firing rate and the firing angle. The concepts like trajectory being followed and the maximum height are being taught. Depending on the acceleration of the gravity, while going upwards the vertical velocity decreases, while descending downwards the vertical velocity increases. Horizontal velocity does not change in frictionless environments. Subjects of during the firing movements complementing each other to 90 degrees the range is same was taught by using visual methods.

Figure 1 (a) the electrification simulation which was explained in 9th grades, (b) shots simulation in the intermediate grades (c) refraction of light simulation in 11th grades
Refraction of light simulation: In figure 1c, in refraction of light simulation, light spreads linearly. At the same time, the light meets with both reflection and refraction. When the light is passing through from an environment with low refraction index to an environment with larger refraction index, it is approaching to normal but when the light is passing through from an environment with large refraction index to an environment with low refraction index, it is moving away from and can make total reflection. The concept of limiting angle is being taught visually.

2.1.2. The Method of Data Analysis

The data of survey which was obtained in the scope of this research was analyzed statistically by using SPSS software. In order to test the significance of difference between mean scores, t-test analysis was used. The mean, standard deviation, standard errors, t-test values and degrees of freedom of answers to this survey questions were calculated. It was tried to estimate the universe values based on the values of sample. Accordingly, the boundaries of confidence intervals of both groups were determined and whether these boundaries intersected with each other or not was evaluated. If there was not an intersection, it was concluded that the average of both groups were different from each other therefore the data values of the first group was bigger than the average of the data values of the second group. If the confidence interval values of both groups intersected, it could be said that there was no difference between groups. The confidence intervals and the boundaries of the values of the data showed that probably %95 they spread right-left in average ± 2 (standard error) (Özbek and Keskin, 2007).

The critical value projected for the %95 safety range of t-statistical value determined as (t_{cr}) 1.97. p value is the acronym of the term of probability in statistics. When we made a comparison by accepting a %5 error, it was concluded that there was a meaningful difference between groups if p<0.05. In this case, if the first comparison is accepted, the difference between data values of both groups is significant. It can be said (p<0.05). As one can see from the explanation above, when comparing the mean scores of the groups standard error is used rather than standard deviation (Özbek and Keskin, 2007).

3. Findings

The statistical results of survey data are shown in Table 3. There is not a distinctive difference between lecturing with simulations and traditional lecturing for each choice of evaluation fields stated in Table 3. The purpose was to determine whether the hypothesis would be accepted or not. The t-test statistic for probably %95 of confidence interval and confidence interval spread were calculated.

### Table 3 the Statistical Results of Survey Data

<table>
<thead>
<tr>
<th>Evaluation Fields</th>
<th>Lecturing Method</th>
<th>Mean</th>
<th>Number of Sample</th>
<th>Standard deviation</th>
<th>Standard error</th>
<th>t-test statistical values</th>
<th>Degree of Freedom</th>
<th>probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meeting the needs of material</td>
<td>With Simulation</td>
<td>3.54</td>
<td>115</td>
<td>0.821</td>
<td>0.077</td>
<td>16.117</td>
<td>228</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Traditional</td>
<td>1.88</td>
<td>115</td>
<td>0.744</td>
<td>0.069</td>
<td>225.863</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motivating Students</td>
<td>With Simulation</td>
<td>3.60</td>
<td>115</td>
<td>0.756</td>
<td>0.070</td>
<td>12.694</td>
<td>228</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Traditional</td>
<td>2.25</td>
<td>115</td>
<td>0.858</td>
<td>0.080</td>
<td>224.433</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increasing the popularity and the attractiveness of the lesson</td>
<td>With Simulation</td>
<td>3.77</td>
<td>115</td>
<td>0.761</td>
<td>0.071</td>
<td>13.278</td>
<td>228</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Traditional</td>
<td>2.22</td>
<td>115</td>
<td>0.986</td>
<td>0.092</td>
<td>214.267</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increasing their learning speed</td>
<td>With Simulation</td>
<td>3.63</td>
<td>115</td>
<td>0.826</td>
<td>0.077</td>
<td>10.967</td>
<td>228</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Traditional</td>
<td>2.36</td>
<td>115</td>
<td>0.921</td>
<td>0.086</td>
<td>225.356</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effects on lesson contents</td>
<td>With Simulation</td>
<td>3.67</td>
<td>115</td>
<td>0.789</td>
<td>0.074</td>
<td>13.732</td>
<td>228</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Traditional</td>
<td>2.21</td>
<td>115</td>
<td>0.827</td>
<td>0.077</td>
<td>227.500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Providing integration with the lessons</td>
<td>With Simulation</td>
<td>3.69</td>
<td>115</td>
<td>0.931</td>
<td>0.087</td>
<td>10.837</td>
<td>228</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Traditional</td>
<td>2.32</td>
<td>115</td>
<td>0.985</td>
<td>0.092</td>
<td>227.262</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Providing different</td>
<td>With Simulation</td>
<td>3.57</td>
<td>115</td>
<td>0.803</td>
<td>0.075</td>
<td>11.848</td>
<td>228</td>
<td>0.000</td>
</tr>
</tbody>
</table>


Meeting the needs of material of the students: It is seen that t –statistic value is bigger than critical value ($t(16.117) > t_0(1.97)$), p probability value is smaller than 0.05. Confidence interval spread of the mean of lecturing with simulations group was found as 3.38 – 3.70, confidence interval spread of the mean of traditional lecturing group was found as 1.74 - 2.02. Since confidence interval values are not intersected, the mean of lecturing with simulations of physics experiments is statistically bigger than the mean of traditional lecturing. These results shows us that there is significant difference in favor of lecturing with simulations of physics experiments for meeting the needs of material of the students ($t(228)=16.117, p < 0.05$).

Motivating students: It is seen that t –statistic value is bigger than critical value ($t(12.694) > t_0(1.97)$), p probability value is smaller than 0.05. Confidence interval spread of the mean of lecturing with simulations group was found as 3.46 – 3.74, confidence interval spread of the mean of traditional lecturing group was found as 2.09 - 2.41. Since confidence interval values are not intersected, the mean of lecturing with simulations of physics experiments is statistically bigger than the mean of traditional lecturing. These results shows us that there is significant difference in favor of lecturing with simulations of physics experiments for motivating students ($t(228)=12.694, p < 0.05$).

Increasing the popularity of the lesson: It is seen that t –statistic value is bigger than critical value ($t(13.278) > t_0(1.97)$), p probability value is smaller than 0.05. Confidence interval spread of the mean of lecturing with simulations group was found as 3.61 - 3.91, confidence interval spread of the mean of traditional lecturing group was found as 2.04 - 2.40. Since confidence interval values are not intersected, the mean of lecturing with simulations of physics experiments is statistically bigger than the mean of traditional lecturing. These results shows us that there is significant difference in favor of lecturing with simulations of physics experiments for increasing the popularity and attractiveness of lessons ($t(228)=13.278, p < 0.05$).

The learning speeds of students: It is seen that t –statistic value is bigger than critical value ($t(10.967) > t_0(1.97)$), p probability value is smaller than 0.05. Confidence interval spread of the mean of lecturing with simulations group was found as 3.47 – 3.79, confidence interval spread of the mean of traditional lecturing group was found as 2.18 - 2.54. Since confidence interval values are not intersected, the mean of lecturing with simulations of physics experiments is statistically bigger than the mean of traditional lecturing. These results shows us that there is significant difference in favor of lecturing with simulations of physics experiments for increasing the learning speeds of students ($t(228)=10.967, p<0.05$).

The content of physics lessons: It is seen that t –statistic value is bigger than critical value ($t(13.732) > t_0(1.97)$), p probability value is smaller than 0.05. Confidence interval spread of the mean of lecturing with simulations group was found as 3.53 – 3.81, confidence interval spread of the mean of traditional lecturing group was found as 2.05 - 2.37. Since confidence interval values are not intersected, the mean of lecturing with simulations of physics experiments is statistically bigger than the mean of traditional lecturing. These results shows us that there is significant difference in favor of lecturing with simulations of physics experiments for the contribution of the content of physics lessons ($t(228)=13.732,p<0.05$).

Integrating students to lessons: It is seen that t –statistic value is bigger than critical value ($t(10.837) > t_0(1.97)$), p probability value is smaller than 0.05. Confidence interval spread of the mean of lecturing with simulations group was found as 3.51 – 3.87, confidence interval spread of the mean of traditional lecturing group was found as 2.14 - 2.50. Since confidence interval values are not intersected, the mean of lecturing with simulations of physics experiments is statistically bigger than the mean of traditional lecturing. These results shows us that there is significant difference in favor of lecturing with simulations of physics experiments for integrating students to lessons ($t(228)=10.837, p < 0.05$).

Providing different perspectives to students: It is seen that t –statistic value is bigger than critical value ($t(11.848) > t_0(1.97)$), p probability value is smaller than 0.05. Confidence interval spread of the mean of lecturing with simulations group was found as 3.41 – 3.73, confidence interval spread of the mean of traditional lecturing group was found as 2.08 - 2.40. Since confidence interval values are not intersected, the mean of lecturing with simulations of physics experiments is statistically bigger than the mean of traditional lecturing. These results shows us that there is significant difference in favor of lecturing with simulations of physics experiments for providing different perspectives to students ($t(228)=11.848, p < 0.05$).
4. Conclusions and Discussion

A significant difference was found between traditional lecturing and lecturing with simulations of physics lesson scores in favor of lecturing with simulations of physics lessons in the subjects of motivating students, increasing the popularity and attractiveness of the lessons, increasing the learning speeds of students, increasing the learning of the students, presenting the content of the lessons in a rich format, using as an instrument for accessing information, organization of the information and integrating students with the lessons.

Today, traditional teaching is carried out in a way in which teachers are active; students are the listeners and teachers load information to students. Loading information without paying attention to the attitude of students toward subject, their interest to the subject, their capacity, expectation and motivation, makes students rote learners. Loading information constantly and rote learning result with the fact that students find lessons boring. Meaningful learning is affected negatively when students do the same things every day. As a result of this, students have difficulties to combine their previous knowledge with recently learned things.

Simulations of physics experiments provide interactive learning opportunities to learners in teaching Physics. Simulations of physics experiments stimulate more senses. They increase student motivation and make the lessons enjoyable. The information is learnt faster and it can be stored long time. Experiment programs that are presented by using simulations provide visual and auditory environments. As a result of this students are able to consolidate subjects more and they can improve their analysis and problem solving abilities. Simulations provide repeating experiments by changing experiment parameters unlike other media such as animations and videos.

Simulations of physics experiments provide using more functional visual and auditory materials that cannot be brought into classroom environment. They increase the popularity of the lesson and make the lessons enjoyable and interesting. They offer positive gains in organizing information and integrating with the lesson and they provide different perspectives together with flexibility in learning environments.

It is concluded that experiment simulations are more effective than traditional teaching methods in accessing documents, images and information. They provide more dynamic environment in terms of graphic, sound and visuals. In line with the views of Köseoğlu and Kavak (2001) that we should use interesting and outstanding examples which are supported with visuals, simulations which are generated after studies offer rich examples and interactive interaction opportunities to students.

Simulations of physics experiments are improving students’ information technologies knowledge. It is a more efficient approach for the systematization of knowledge and for achieving information. Students express the fact that simulations systematize their knowledge and help them to combine existing knowledge and the new knowledge.

In our rapidly developing age, necessary precautions should be taken for our students to be able to use information technologies efficiently. Information Technology classrooms should be organized properly. Teachers should actively use simulations of physics experiments that can easily be found via Internet. Simulations should be used in laboratory environment together with laboratory applications. The effects of having IT classrooms and laboratories in the same environment on students should be researched.

Miller (2010) stated the fact that schools should keep pace with computer technologies, lessons should be integrated with these technologies and teachers and students should be prepared to these technologies. The effects of supporting virtual environments that are being used now with virtual reality environments that give the sense of presence in that environment and haptic devices that give the sense of touching on physics education should be researched. Simulations of physics experiments that were prepared in two-dimensional environments should be improved and three-dimensional virtual reality environments in which haptic devices are used should be provided to teachers and students.

References


Üstünel H. (2010). The Effect Computer Game Preferences for Gifted Students on Their Academic Achievement the Presentation of Course Seminar in Computer Engineering Program. Trakya University.

http://phet.colorado.edu/new/simulations
http://www.phy.ntnu.edu.tw/ntnujava