COMPARISON OF COMPUTER-AIDED INSTRUCTION AND INQUIRY-BASED TEACHING ON STUDENTS' ANXIETY TOWARDS SCIENCE

Prof. Dr. Hasan KAYA
Erciyes Üniversitesi, Eğitim Fakültesi,
hasankaya@erciyes.edu.tr

Arş. Gör. Dr. Aslı SAYLAN KIRMIZIGÜL
Erciyes Üniversitesi, Eğitim Fakültesi,
aslisaylan@erciyes.edu.tr

ABSTRACT
The present study was conducted to explore the effect of the use of computer-aided and inquiry-based teaching approaches on 7th grade students' anxiety towards science. The research was carried out in the spring semester of 2016-2017 academic year with the participation of 69 students from two classes of a middle school in Kayseri, Turkey. The pre-test and post-test quasi-experimental design without a control group was used. Within the scope of the study, "Reflection in the Mirrors and Absorption of the Light" unit was taught through computer-aided instruction in experimental-1 group, and inquiry-based teaching in experimental-2 group by developing suitable activities for each approach. In the study, data were collected through Science Anxiety Scale. The data were analyzed through paired-samples and independent samples t-tests. According to the results, although both teaching approaches decreased the level of science anxiety, it was seen that computer-aided instruction was more effective than inquiry-based learning. In addition, in terms of five sub-dimensions of the scale, there are significant differences between two groups' post-test scores in favour of experimental-2 group. Lastly, although girls were more anxious towards science based on the pre-test scores, no significant difference was found between post-test scores in terms of gender.

Keywords: Science anxiety, Computer-aided instruction, Inquiry-based teaching

INTRODUCTION
The middle school years, from grades 5 to 8, have a critical importance of learning science. Not only cognitive characteristics, but also affective features such as attitude and motivation affect the learning process. It is known that there is a close relationship between anxiety and learning. Anxiety is the feeling that occurs when situations threaten the ability to meet basic human needs such as competence, control, self-esteem (Fiske, Morling, & Stevens, 1996), whereas science anxiety is the total of experiences such as fail to solve a science problem or understand a scientific concept, failing a science exam (Mallow, 1986). It is known that a high level of science anxiety leads to a decrease in students' success and attitude towards science, and discourage them from entering science-related professions (Udo, Ramsey, & Mallow, 2004). For this reason, it is important to determine the students' anxiety levels and eliminate the reasons of anxiety in order to stimulate their interests, attitudes and achievement towards science.

In the literature, it was emphasized that physical phenomena such as light and mirrors are not sufficiently related to daily life and remain abstract. Consequently, these concepts cannot be understood clearly and may cause science anxiety (Colin & Viennot, 2001; Galili & Hazan, 2000). It is thought that the teaching methods or activities used by teachers have important effects on students' science anxiety (Jegede, 2007). Active student participation in science course will enhance students' self-confidence and lower their science anxiety levels (Kaya & Yıldırım, 2014), enable concretization of the scientific concepts and link them with daily life (Zacharia, 2003). At this point, computer-aided instruction (CAI), which plays an important role in the concretization of abstract concepts by addressing many sense organs, and inquiry-based teaching (IBT), which enable students to reach a solution by researching, questioning, hypothesizing and interpreting data (Perry & Richardson, 2001), come to the fore.

Computers play an important role in doing dangerous experiments, obtaining and processing data quickly, and providing immediate feedback. In several studies, it was concluded that computer reduces anxiety when it is used for educational purposes (Newhouse, 2002; Rutten, van Joolingen, & van der Veen, 2012). The main approach suggested by the Ministry of National Education in Turkey is guided inquiry. In guided inquiry, which was used in this study, the teacher does not give the information directly, instead of this, the students investigate to find concepts that have been determined by the teacher. For both teaching approaches, the students involved directly in the learning process almost all the time.

"Reflection in the Mirrors and Absorption of the Light" unit in Turkish science curriculum is well suited for teaching through both CAI and IBT approaches, and there is no accessible study comparing the effects of these two approaches on students' anxiety levels. In the new science curriculum, it was stated that "Individuals' characteristics such as interest, attitude, value and success that are subject to measurement and evaluation may change over time. For this reason, instead of measuring these properties at one time, measurements that take into account changes in the process should be used." (MoNE, 2018). Within this context, the research question of the current study was determined as "Is there a statistically significant difference between science anxiety levels of the 7th grade students who taught "Reflection in the Mirrors and Absorption of the Light" unit through CAI and IBT?" Within the scope of this research question, the following sub-problems were searched:

1. Is there a statistically significant difference between pre-test and post-test scores of the students in the experimental groups?
2. Is there a statistically significant difference between the post-test scores of experimental groups in terms of entire scale, and in terms of sub-dimensions of the scale?
3. Is there a statistically significant difference between pre-test and post-test scores of the students with respect to the gender?

METHOD
Research Design
In the study, the pre-test and post-test quasi-experimental design without a control group was used. The instrument was conducted two times, before and after the five-weeks implementation.

Sample
The sample, which was selected through convenience sampling method, consisted of 69 (34 girls, 35 boys) 7th grade students from two classes of a middle school in Kayseri, Turkey in 2016-2017 spring semester. While one class including 34 students (17 girls, 17 boys) was assigned to be the experimental group-1 (E1), one class including 35 students (17 girls, 18 boys) was assigned to be the experimental group-2 (E2).

Instrument
Science Anxiety Scale developed by Uluçınar Sağır (2014) was used to determine the students' anxiety levels towards science in the study. This 5-point Likert scale has 25 items and 5 sub-dimensions namely; (1) focusing on class, (2) lack of self-confidence, (3) studying and anxiety for the exams, (4) disturbance, (5) interest. These five factors include 7, 6, 6, 4 and 2 items, respectively. While higher total scores obtained from the scale indicate high science anxiety level, lower total scores indicate low science anxiety level.

Implementation
"Reflection in the Mirrors and Absorption of the Light" unit has six main subjects: Mirrors and their usage, image formation in mirrors, interaction of light with matter, white light contains all colors, reflection and absorption of light, the importance of solar energy. During 5 weeks (4 hours a week), unit was taught to E1 through CAI, and to E2 through IBT. Each course was evaluated by two observers using teacher and student evaluation rubrics which were prepared by the researchers. In E1 group, subjects were taught using smartboard, computers through digital images, videos, animations, simulations (i.e. Algodoo), interactive tests. In E2 group, students were challenged to solve the given problem through six main steps: curiosity, determination of the problem, hypothesizing, data collection, data analysis and evaluation, presentation, reinvestigation.

Data Analysis
SPSS (Statistical Package for the Social Sciences) Version 24.0 was used for analysis of the quantitative data. In order to examine the first sub-problem, paired-samples t-test was conducted; whereas to examine second and third sub-problems independent samples t-test were conducted.

RESULTS
Independent samples t-test results indicated that no significant difference was found between E1 (M=58.00, SD=10.354) and E2 group (M=58.14, SD=8.218) students' pre-test mean scores [$t(67)$=0.064, p>.05]. Similarly, no significant difference was found between two groups' pre-test mean scores in terms of the five sub-dimensions (p>.05). On the other hand, a significant difference was found between pre-test mean scores of girls (M=60.41, SD=9.026) and boys (M=55.80, SD=9.042) in favour of girls [$t(67)$=2.120, p<.05]. Eta-squared was found as 0.06, suggesting a small effect size (Cohen, 1988).

Paired-samples t-test results indicated that for E1 group, there was a significant difference between pre-test (M=58.00, SD=10.354) and post-test mean scores (M=42.68, SD=9.524) in favour of pre-test scores ($t(33)$

=6.006, p<.05). Eta-squared was found as 0.35, suggesting a large effect size (Cohen, 1988). Different from E1 group, for E2 group, there no significant difference was found between pre-test (M=58.14, SD=8.218) and post-test mean scores [(M=57.80, SD=8.242, t(34) =0.170, p>.05]. In other words, CAI activities in E1 group significantly reduced the anxiety levels of the students, whereas IBT activities did not make any significant difference.

According to independent samples t-test results, there was a significant difference between E1 (M=42.68, SD=9.524) and E2 groups (M=57.80, SD=8.242) students' post-test scores in favour of E2 group [t(67)=-7.060, p<.05]. Eta-squared was found as 0.43, suggesting a large effect size (Cohen, 1988). In Figure 1, a bar graph regarding the pre and post-test total average scores of E1 and E2 was given.
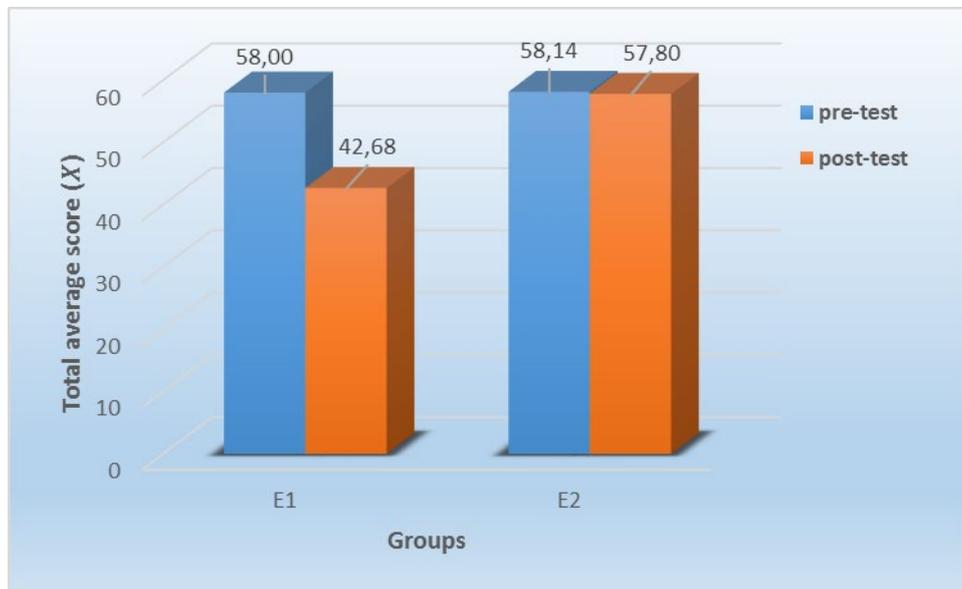

Figure 1. Bar graph regarding the comparison of the groups' pre and post-test total average scores

The results also indicated that regarding post-test scores, there is a significant difference between E1 and E2 groups for all the five sub-dimensions in favour of E2 (p<.05) (Table 1). For focusing on class, lack of self-confidence, studying and anxiety for the exams, disturbance and interest sub-dimensions, eta-squared values were found as 0.28, 0.32, 0.22, 0.23 and 0.06, respectively. While 0.06 indicates a small effect, other values indicate large effects (Cohen, 1988).

Table 1: Independent samples t-test results according to the average post-test total scores for Science Anxiety Scale sub-dimensions

Sub-dimensions	Group	N	Min.	Max.	M	SD	t-test		
							t	p	η^2
1. Focusing on class	E1	34	7	19	10.18	3.371	-5.061	0.000	0.28
	E2	35	7	21	14.17	3.185			
2. Lack of self-confidence	E1	34	6	19	10.94	3.550	-4.354	0.000	0.32
	E2	35	9	26	14.77	3.750			
3. Studying and anxiety for the exams	E1	34	6	18	10.00	3.153	-5.663	0.000	0.22
	E2	35	8	21	14.17	2.965			
4. Disturbance	E1	34	4	12	7.88	2.332	-4.416	0.000	0.23
	E2	35	6	15	10.26	2.133			
5. Interest	E1	34	2	7	3.68	1.273	-2.110	0.039	0.06
	E2	35	2	8	4.43	1.668			

In Figure 2, a line chart regarding the post-test mean scores of the groups for the five sub-dimensions was given. According to the chart, students in both groups had highest mean score in the fourth sub-dimension (disturbance), whereas they had lowest mean score in the first sub-dimension (focusing on class).
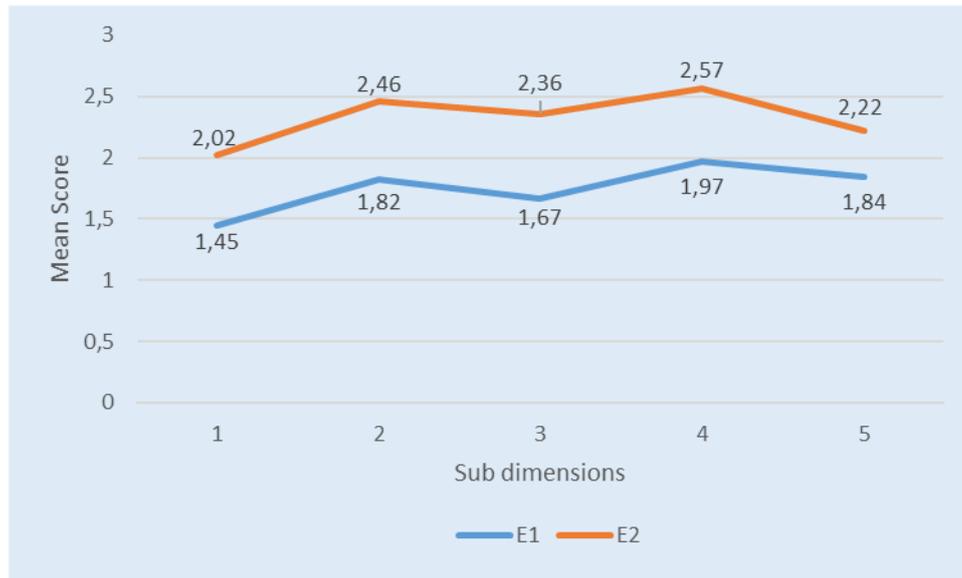
Figure 2. Line chart for the comparison of the groups' post-test mean scores regarding the five sub dimensions

In Figure 3 and 4, line charts regarding the pre and post-test mean scores of the groups for the five sub-dimensions were given. According to Figure 3, anxiety levels of the students in E1 decreased for all the five sub-dimensions. On the other hand, anxiety levels of the students in E2 decreased for three sub-dimensions, while the levels increased for the second and third sub-dimensions, namely lack of self-confidence and studying and anxiety for the exam.
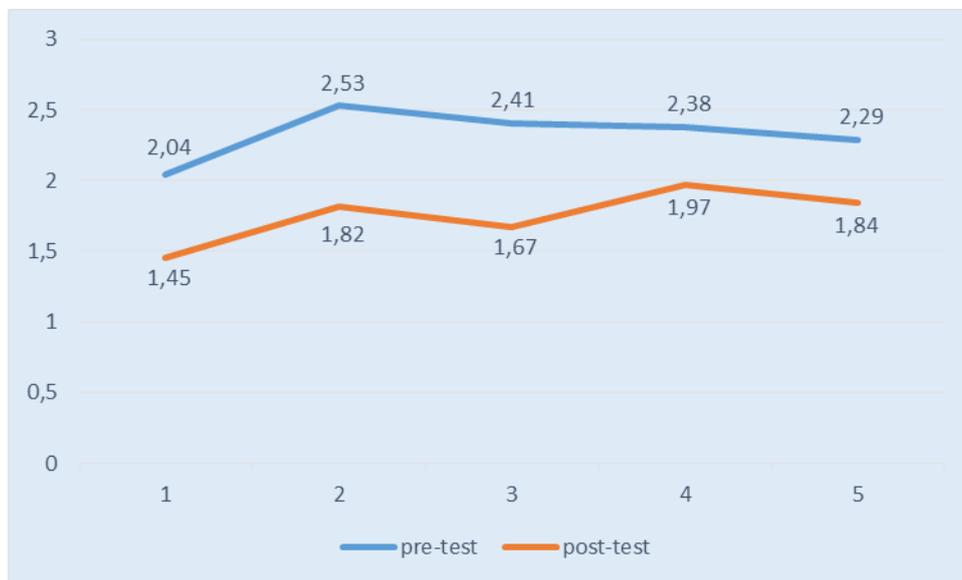

Figure 3. Line chart for the comparison of E1's pre and post-test mean scores regarding the five sub dimensions
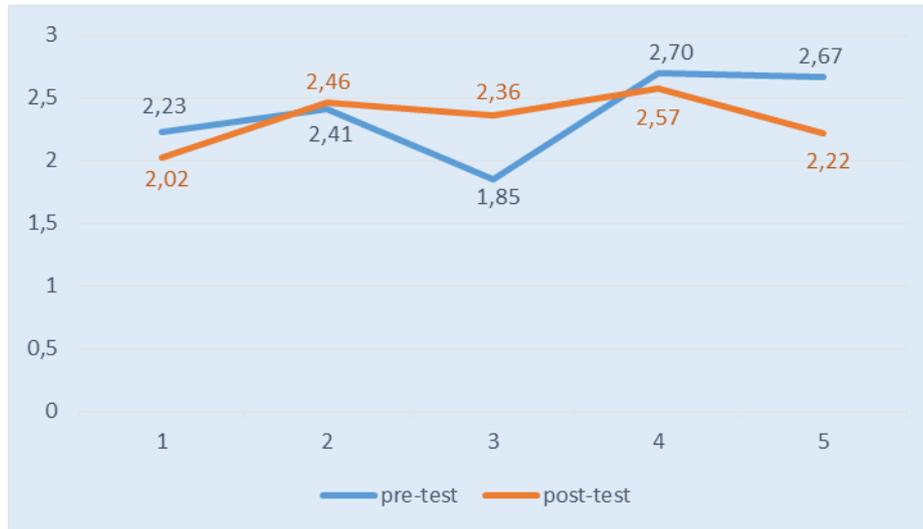
Figure 4. Line chart for the comparison of E2's pre and post-test mean scores regarding the five sub dimensions

Lastly, independent samples t-test results indicated that no significant difference was found between post-test mean scores of girls (M=49.88, SD=11.083) and boys (M=50.80, SD=12.343), [t(67)=-0.325, p>.05].

DISCUSSION OF FINDINGS AND IMPLICATIONS

The research findings revealed that both teaching approaches decreased students' anxiety towards science. However, CAI is more effective than IBT. IBT usually involves collaborative activities and this may be the reason for the anxiety levels of the students in E2 increased for lack of self-confidence, and studying and anxiety fort he exams sub-dimensions. Unlike IBT, students usually work individually and feedback is given directly to the student in CAI. Therefore, students do not worry about being criticized by their teacher or friends when they make a mistake and this encourages students to participate in the course (Sevim, 2015), and their self-confidence increases while anxiety for the exams decreases. It is thought that the use of computer, which the students frequently use in daily life, in the learning process actively makes students feel more comfortable and decreases their anxiety levels (Newhouse, 2002; Rutten, van Joolingen, & van der Veen, 2012).

According to the findings, while the teaching approach used had a small effect on interest sub-dimension, it had major effects on focusing on class, lack of self-confidence, studying and anxiety for the exams and disturbance sub-dimensions. Accordingly, it is thought that more time should be spent to change the level of interest than other variables. In parallel with this finding, related literature indicated that changing the level of attitude or interest require more time (Neiderhauser, 1994; Sadi & Çakıroğlu, 2011).

In the study, it was found that gender has a small effect on pre-test mean scores. Accordingly, girls are more anxious towards science. On the contrary, no significant difference was found between post-test mean scores of girls and boys. In the related literatüre, no study was reached that examine the effects of CAI and IBT on middle school students' science anxiety levels in terms of gender. However, a limited number of studies examining the effect of gender on middle school students' science anxiety revealed that gender had no statistically significant effect on science anxiety (Akpınar, Yıldız, Tatar, & Ergin, 2009; Gömleksiz & Yüksel, 2003; Kurbanoğlu, 2014). Therefore, this finding regarding post-test scores is consistent with the literature.

Since this study is limited to the selected sample and teaching approaches, it is recommended that future studies be conducted to validate the findings by incorporating- a larger sample size, different grade groups, a longer period of time, and different teaching approaches.

ACKNOWLEDGEMENT

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