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## COMPARISON OF STUDENTS' LEARNING AND ATTITUDES IN TECHNOLOGY SUPPORTED AND LABORATORY BASED ENVIRONMENTS

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**Abstract:** This research study aimed to compare students' conceptual knowledge and attitudes towards physics lesson who were separately taught with three different methods. The main research question was as follows: Are there significance differences among technology supported teaching, laboratory-based teaching, and curriculum-based teaching in terms of students' learning and attitudes? True experimental design was carried out for this research. The participants of this study were 144 9<sup>th</sup> grade students studying in an all-boys state high school. The students who were in the technology supported classroom constituted the first experimental group while the students in the laboratory based classroom comprised the second experimental group. There was also one control group whose students were taught based on the curriculum. Each group had 48 students. The teacher of three groups was the same. Data were collected in the physics lessons. The students' conceptual learning was assessed with the help of "Force and Motion Achievement Test". This test was applied before and after the treatment with an eight-week time difference. In order to determine any change in the students' attitudes towards physics lesson, "Physics Lesson Attitude Scale" was used. Effect sizes were calculated for the changes in students' knowledge and attitudes. Findings showed significant differences between the experimental groups and control group. In other words, when technology or laboratory approach was embedded in the instruction, the students became better learners and their attitudes increased. Results also presented no significant differences between the experimental groups.

**Keywords:** Learning, attitude, technology, laboratory, science.

### Introduction and Purpose of the Research

Each passing day we encounter a new technological development and the use of technology has become an indispensable habit for people. Researchers have stressed the importance of effective use of technology in science teaching and learning because through the use of technology, students' scientific investigations and reasoning can be constructively developed and help students connect constructed knowledge to practical work (McFarlane & Sakellariou, 2002). Technology simultaneously ushers the tasks of creating, evaluating, analyzing, and applying through collaboration into the classroom while generating greater enthusiasm for learning (Cicconi, 2014), which is related to attitude. Ranging from drawings on a blackboard or interactive multimedia simulations to etchings on a clay tablet or Web-based hypertexts to the pump metaphor of the heart or the computer metaphor of the brain, technologies have constrained and afforded a range of representations, analogies, examples, explanations, and demonstrations that can help make subject matter more accessible to the learner (Koehler & Mishra, 2006).

Improving learning experiences for all students is the ultimate goal of research in technology use in education; however, there is well-placed concern that even when good technologies are available, they are not being used to their full potential to support students' learning (Forsell, 2011). Therefore, research has focused on the impact of using technology on students' cognitive and affective skills. Marty (1985), for example, investigated the

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effects of interaction with computerized simulation game on high school students' achievement and attitudes. Analysis revealed a significant difference in change of class means on achievement favoring use of the computer game and very little difference in the change of class means on attitudes. Grimm (1995) examined the effect of technology rich educational environments on student academic achievement and attitude by comparing type of school (technology-rich school (TRS) and traditional school (TS)). The overall findings indicated that TRS environments contributed to increased academic achievement of 4<sup>th</sup>-grade, 6<sup>th</sup>-grade, and 11<sup>th</sup>-grade students and contributed to students' overall attitude for 6<sup>th</sup>-grade and 11<sup>th</sup>-grade students. Jimoyiannis and Komis (2001) investigated the effect of using computer simulations in learning of speed and acceleration concepts. At the end of the application, the experiment group in which the simulations were used among the students was found to be more successful academically. Saka and Yilmaz (2005) aimed to develop instructional materials based on computer-aided study sheets and to determine the effect on the achievement level of the concepts that students have difficulty in understanding about electrostatics in the 9th grade physics course. Results indicated that study sheets for computer-aided physics teaching had an efficacious effect in teaching the electrostatic concepts. Additionally, students stated that they liked physics but they had difficulty in understanding some of the topics in abstract concepts in physics. They said that the prepared material was interesting, practical and easy to use.

On the other hand, hands-on approach in science education provides the student with engaging activities during the learning process and allows students to fully participate in the learning process because students should learn science by experiencing it (Wiggins, 2006). Research implies that use of the laboratory and hands-on activities are effective instructional techniques to increase achievement in science knowledge and when properly designed, they can influence attitudes toward science in a positive way (Freedman, 1995).

Some research investigated the benefits of laboratory instruction on students' attitudes towards science. For instance, Norton (1985) compared college students in the experimental group who were told to work independently and did not get any instructional help with the students in the control group who continued with step-by-step verification laboratory exercises, working in pairs with direct supervision and instruction. Results indicated that the treatment of the independent laboratory investigation did not have a significantly different effect on the dependent measures of critical thinking ability and/or scientific attitude when compared to the effect of the performance of verification laboratory exercises by a control group. Freedman (1997) investigated the use of a hands-on laboratory program as a means of improving student attitude toward science and increasing student achievement levels in science knowledge. It was concluded that laboratory instruction influenced, in a positive direction, the students' attitudes toward science, and influenced their achievement in science knowledge. Demirtas-Yilmaz (2014) examined 30 studies regarding the achievement of students compared to the traditional and laboratory based methods in science education in Turkey between 2000 and 2012 by using meta-analysis. Results showed that the laboratory based teaching method was much more effective in increasing the academic achievement of the students than the traditional teaching method.

Some research compared the impact of technology with effects of laboratory on learning (Akpan, 2002; Bozkurt & Sarikoc, 2008; Coramik, 2012; Darrah et al., 2014; Finkelstein et al., 2005; Zacharia & Anderson, 2003). Akpan (2002) revealed that teaching with simulation support was as effective as teaching with real laboratory experiments in his work on anatomy and organisms with high school students. He suggested that simulations might be an alternative to real laboratory experiments. The work of Bozkurt and Sarikoc (2008) was carried out with university students where the concept of circuit in alternating current was studied. For the study, a virtual lab group using computer simulations and a traditional lab group using real experimental materials were created. At the end, the virtual laboratory group was found to be quite successful compared to the traditional laboratory group. Finally, Coramik (2012) explored the outcomes of using computers and experiment-assisted activities in the teaching of the magnetism unit in the 11th grade physics course to the students' academic achievement and attitudes towards the physics course. It was seen that the academic achievement and attitudes scores of the students in the experiment-supported teaching group were higher than the scores of the students in the computer-assisted teaching group.

Results of the studies can change based on the subject, discipline and how the technology and laboratory activities are implemented. More research is needed to compare using technology with laboratory usage in terms of students' learning and attitudes. Hence, the following research question put a light on this research: Are there significance differences among technology supported teaching, laboratory-based teaching, and curriculum-based teaching in terms of students' learning of dynamics and their attitudes towards physics lesson.

## **Methodology**

True experimental design was used for this research (Krahtwohl, 1997). There were two experimental groups and one control group. The first experimental group was instructed with technology supported teaching and the second experimental group was instructed with laboratory based teaching. The control group followed the

curriculum and was exposed to curriculum based teaching. The participants of the study were 144 9th grade male students. Each group had 48 students. The research was conducted in a physics class in an all-boys state high school. The teacher of all groups was the same person. The students were taking the class two hours a week. The instruction continued in the dynamics unit and lasted 8 weeks. Simulations, video recordings, smart board, tablets and z-book were used as the technology in the first experimental group. The second experimental group did hands on science by using experiment sets.

Quantitative research methods were used to collect data. In order to measure the changes in the participants' learning of dynamics, Force and Motion Achievement Instrument developed by Gokalp (2011) was administered as pre-test and post-test. The instrument had 30 questions including 16 multiple-choice, 12 open-ended, and 2 true-false questions. The scoring was between 0-54. The students' attitudes towards physics class were assessed by applying Physics Class Attitude Scale developed by Geban et al. (1994) before and after the treatment. This instrument consisted of 15 items with 5-point Likert scale. The scoring was between 15-75. Descriptive statistics and t-tests were performed to analyze the data. Effect sizes were calculated for the changes in the groups. Reliability measurements were made with the help of Cronbach alpha test.

## Results and Discussion

### Results for Learning

With regard to Force and Motion Achievement Test, Cronbach Alpha value for the pre-test was found as .40 whereas this value was calculated as .67 for the post-test. Due to the fact that this instrument measured student learning, the low reliability can be expected for the first application where the students were not familiar with the concepts asked in the instrument. To better identify which approach had the most positive effect on the students learning, the groups' pre-tests and post-tests were compared with each other by implementing independent t-tests. No significant differences were found among the groups' pre-test results considering learning. However, significance differences were found between the post-tests of the technology group and curriculum-based group as well as between the laboratory group and curriculum group as presented in Table 1. The mean value of the technology group ( $\bar{x} = 27.56$ ) was significantly higher than the mean value of the curriculum-based group ( $\bar{x} = 20.13$ ,  $p = 0.00$ ). Similarly, the laboratory group's mean value ( $\bar{x} = 27.20$ ) was significantly higher than the curriculum-based group's mean value ( $\bar{x} = 20.13$ ,  $p = 0.00$ ). The effect size between the technology and curriculum based groups was .58 and the effect size between the laboratory and curriculum based groups was .61. These values were not found to exceed Cohen's (1988) convention for a large effect ( $d = .80$ ) but they were in medium level. In addition, there was not any significant difference between the post-tests of the technology group and laboratory group.

Table 1. Independent t-test results of the groups' post-tests regarding learning

Groups	n	$\bar{x}$	ss	t	sd	p
Technology	45	27.56	5.81			
Laboratory	44	27.20	4.81	.310	87	.757
Total	89					
Technology	45	27.56	5.81			
Curriculum-based	39	20.13	4.38	6.537	82	.000
Total	84					
Laboratory	44	27.20	4.81			
Curriculum-based	39	20.13	4.38	6.979	81	.000
Total	83					

Findings indicated that the students in all groups improved their learning of dynamics concepts after the instruction; however, the increase in the curriculum-based group was less than the increase in technology and laboratory groups. Although high school physics curriculum has been revised recently, it needs to support more activities based on technology and laboratory.

Technology group developed more knowledge than the curriculum based group. This result is consistent with the results presented by Jimoyiannis & Komis (2001). Laboratory group performed more learning progression than

the curriculum based group. This finding is in line with the results that emerged from the research by Freedman (1997) and Wiggins, (2006). At the end of the instruction, there was not any significant difference in the students' learning who studied either in the technology group or in the laboratory group. This result supports what Akpan (2002) and Darrah et al. (2014) found in their research.

### Results for Attitudes

The application of Physics Class Attitude Scale had high reliability where Cronbach Alpha value for the pre-test was .90 and it was .93 for the post-test. No significant differences were found among the groups' pre-test results when the attitude took into account. Nonetheless, significance differences were found between the post-tests of the technology group and curriculum-based group as well as between the laboratory group and curriculum group as presented in Table 2. The mean value of the technology group ( $\bar{x} = 54.72$ ) was significantly higher than the mean value of the curriculum-based group ( $\bar{x} = 45.38$ ,  $p = 0.02$ ). Likewise, the laboratory group's mean value ( $\bar{x} = 56.45$ ) was significantly higher than the curriculum-based group's mean value ( $\bar{x} = 45.38$ ,  $p = 0.00$ ). The effect size between the technology and curriculum based groups was .35 and the effect size between the laboratory and curriculum based groups was .42. In addition, there was not any significant difference between the post-tests of the technology group and laboratory group. When the students involved with more activities including technology and laboratory, their attitudes towards physics class enhanced.

Table 2. Independent t-test results of the groups' post-tests regarding attitudes

Groups	n	$\bar{x}$	ss	t	sd	p
Technology	43	54.72	8.57			
Laboratory	47	56.45	7.80	-1.000	88	.320
Total	90					
Technology	43	54.72	8.57			
Curriculum-based	37	45.38	15.10	3.331	55.090	.002
Total	80					
Laboratory	47	56.45	7.80			
Curriculum-based	37	45.38	15.10	4.054	50.975	.000
Total	84					

Technology group developed more attitude towards physics class than the curriculum based group. This result is consistent with the results presented by Marty (1985) and Grimm (1995). Laboratory group performed more progression in their attitudes than the curriculum based group. This finding is in line with the results that emerged from the research by Freedman (1997).

Attitude change takes time and needs having experiences. Since there was not any change in terms of instruction in the curriculum-based group, any change in attitudes of the students' in curriculum-based group was not expected. Since the participants were ninth grade students and studied physics discipline for the first time, eight-week duration was enough for the students in the technology and laboratory groups to change their attitudes.

### Conclusions and Suggestions

Two conclusions can be drawn from the study. First, when students are given a chance to engage with technology and laboratory environments, they reach higher level of scientific understanding and tend to develop more positive attitudes toward physics class. And second, there is no difference between the technology supported instruction and laboratory based instruction in terms of their impact on students' learning of dynamics concepts and attitude towards physics class.

According to the results of the research, the following suggestions can be made for the instructors:

- Technology would be used during the instruction where there is a lack of laboratory materials or in situations where experiments cannot be conducted in the school environment to facilitate learning and attitude.
- Students should be taught how to use technology for the right purposes at the right time.

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