Journal of Human Sciences
ISSN: 2458-9489
Volume: 13 Issue: 3 Year: 2016

Application and evaluation of biology laboratory experiments with computer-based digital experimental tools[1]

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Abstract
It is widely accepted that learning-science-by-doing and/or facilitating meaningful experience is preferred over rote memorization in the science classrooms. To this end, this study shows that using the computer-based digital experimental tools in the biology laboratory can function as activities that can facilitate their learning to be more effective, and foster positive attitudes towards learning science and high level of self-efficacy in the subject area. The aim of this research is to determine the students' perception on their self-efficacy in teaching science, their attitudes towards the laboratory course, and their self-efficacy in using the computer-based digital experimental tools. The research was carried out with 28 students who were registered in the Department of Biology Education, at a major university in Turkey. The research employed one group pretest-posttest model experimental design. As a data collection tools, Teaching Self-Efficacy Scale developed by Tschannen-Moran & Hoy (2001), Laboratory Self Efficacy Scale developed by (2009) and Laboratory Attitude Scale developed by Ekici (2002) were used in this study. The analyses of the study were carried out using SPSS 20 program. The descriptive statistics, normality test, T-test and Wilcoxon signed rank test were used. The results of the research showed that the computer-based learning with digital experimental tools had a positive impact on the students' perception on their self-efficacy for teaching science and self-efficacy levels for using the computer-based digital technology.

Keywords: Biology education; Digital experimental tools; Laboratory practices.

1. Introduction

One of the more symbolic representations of a country's development is largely reflect by its education level. To achieve this progress and technological advances often requires the flux of educated workers in the Science, Technology, Engineering, and Mathematics (STEM) fields. As such, education policy plays an important role in increasing the quality of education. To this end, education policies and reforms need to keep up with the changing economic markets, both nationally and globally, reflect the innovations of the latest technologies, evaluate the aims of education for the future, and thus implement the necessary investments to achieve these educational goals. In today's modern society, there is a growing pressure for the individuals to acquire the "21st Century Skills" such as the ability to conduct research, make enquiries, have

[1] This study included a part of a Scientific Research Project named The Design Application and Evaluation of Biology Laboratory Experiments with Computer-Based Digital Experimental Tools.
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scientific process skills**,** and be productive by applying the latest technological and scientific knowledge. As such, developing scientific literacy is an important aspect of life in the 21st century, since most of the innovations stem from the advances in science and technology. Educating the individuals to become scientifically literate citizens of the 21st century is very much feasible through science education. As such, it is important to understand how this can be accomplished in a science laboratory class setting.

Students have an instinct to understand and interpret their environment and to search for an order in this complex world. Today, one of the goals in science education in Turkey is to facilitate the children's questioning and inquiries into understanding the nature in the most effective way possible. Another goal is to ensure that children learn to adapt to this constantly changing world around them. To this end, understanding science and being able to apply technology are very important not only in the life of the individuals, but also for the welfare of our society (YOK, 1997; Gul & Sozbilir, 2015).

It is evidence that the technological advancements occur concurrently with the progress of science. One of the growing areas in science studies is laboratory research. The beginning of implementing laboratories in science education dates backs to the 1850s. Interestingly, prior to that, laboratory applications were considered a waste of time in schools. The laboratories first became part of the school science curriculum in the mid-19th century where scientific experiments were demonstrated in front of students after providing them with the theoretical foundations. Now they are used widely in schools to provide students with the opportunities to conduct the experiments themselves, both individually and in groups. Furthermore, the role and the importance of laboratories have gone through a fundamental change. Laboratories, which were once used to be a place where scientific knowledge was demonstrated and proven, have transformed into a place where scientific knowledge is explored and socially constructed by students, both individually or in small groups.

In Turkey, the importance of learning science has been seen by the authorities of Ministry of National Education. As such, various science programs developed in the United States in the 1960s were put into practice as an attempt to improve the quality of science education in Turkey. However, it is hard to determine the efficacy of these adopted programs, especially the ones that foregrounded the implementation of laboratory courses. One of the various reasons for this uncertainty could be that that even though the role and the importance of laboratories in science education are accepted the oretically, there are still deficiencies and shortcomings in practice.

In order to effectively implement the laboratory instruction in science education, the purposes and methods of the laboratories needs to be re-evaluated (Ayas and et al., 1994). Yaman and Soran's research (2000), reported the factors that seem to contribute to the minimal number of experiments being performed in schools: a) the lack of laboratory courses, b) the lack of specificity in the purpose of the laboratory courses, as they would often be shared with other science classes, and c) the inadequate number or the poor qualities of the laboratory tools. Given these findings, it is not surprising that the Turkish students placed the lowest on the TIMSS (Third International Mathematics and Science Study) in the subject area pertaining to the laboratory use, and ranked 35th out of the 40 countries in PISA (Program for International Student Assessment) attended by 40 countries (Atici & Gokmen, 2010).

In Turkey, biology education is not effective due to the lack of laboratory tools**,** the large class sizes, and the impacted curriculum**.** Moreover, teachers are not adequately equipped with the information on new teaching methods. As such, these challenges that both students and teachers face in schools may lead to negative attitudes towards the biology courses. In such adverse conditions, meaningful learning does not take place, and the acquired knowledge does not reflect the real life situations that may contribute too many misleading notions about science learning misconceptions. It is widely accepted that learning-science-by-doing and/or facilitating meaningful experience is preferred over rote memorization in the science classrooms (Yager, 2000). Thus, effective implementation of laboratory instruction in the science curriculum can function as the

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powerful learning opportunity for the students to experience meaningful and hands-on science learning.

In recent years, technology has been getting integrated into the science curriculum, which contributed to the rise in the need to educate trains to know how to effectively use technology in the science classrooms. With this upcoming change in Turkey, taking the required technological courses has become a critical and an important aspect of their education, so that they can meet the needs of their future students (Olgun, 2011). It may be possible to develop various kinds of materials that appeal to more senses using technology. In response to this, developing the appropriate teaching and learning materials that can prepare the pre-service teachers to develop technological efficacy has emerged as an important contribution to science education as well as the teacher preparation programs in Turkey (Sonmez, 2004).

A body of literature in the education research focuses on identifying factors that can impact the learning environment, with the aim to facilitate the high level of learning in a short amount of time. Consequently, teaching methods are discussed to create such a learning environment (i.e., fostering the students' motivation, and facilitating the mobilization and interaction of the students, and etc). Many countries are re-evaluating their current educational system, which promotes the notion that learning can occur effortlessly in this manner. Not surprisingly, one of the main criticisms about foregrounding the notion of progress and growth is that science education should focus its efforts on educating individuals to become problem-solvers and critical thinkers (Tezbasaran, 1997). When we have citizens who can think critically, we can then keep up with today's rapidly developing technology and apply modern methods in all areas of life. This requires developing quality of science education programs that considers the effective integration of technology and implementation in all related-subject areas in schools.

It is necessary to provide the equipment and tools to effectively integrate technology into the classroom. For students, it is essential to learn to conduct research, be creative, and avoid rote memorization during their year early of science education, and to embody science education as being effective and functional. To this end, it is necessary to use the appropriate teaching methods, especially implementing laboratory activities that will encourage students to learn science by doing and through their meaningful experiences, which would provide them with the appropriate places, equipment, and tools to help further their laboratory studies. As such, the implementation of laboratory activities in science courses has many benefits. Some of them are as follows:

1)Teachers would ensure that the students engage in the learning process from the more critical perspective and appeal more senses when participating in the laboratory activities.

2) It is possible to make use of a variety of resources, tools and equipment as needed for the laboratory experiment.

3)Due to the laboratory learning environment that supports the learn-science-by-doing and meaningful experiences, students take on the role of an active learner.

4) Students who engage in the laboratory activities understand the process by which scientific knowledge is constructed.

5) Through laboratory activities, students acquire the investigation and observational skills.

6) Students can experience self-paced and independent learning environment.

7) The knowledge that students obtain through laboratory activities would retain long-term, because they learn science-by-doing and meaningful experiences.

8) It fosters the motivation and interests of the students through interesting experimentations in the laboratories.

9) Students learn the iterative process of doing science experiments in laboratories.

In addition to the laboratory practice, computer-based applications are one of the most important tools used in education. According to Alkan (1998), computers undertake the most important role as supporting educative materials in education. Computers will find an application place where they are used together with teachers or separately, with other methods and techniques or supporting them in computer- based instruction. Computers and other technologies can be applied in the education setting where teachers can implement them in the classroom along with other teaching methods, or as a single most important teaching tool. Thus, there are many positive uses of computer-based digital experimental tools within the laboratory applications. These can be summarized as follows:

1) Even the tiny physical changes can be measured with great precision via digital experiment tools.
2) Measurements of one or several variables can be recorded on computers via digital tools. As the number of variables increases, the experiments will take a longer time, but with the technology, these experiments can produce the results in a short time.
3) The test results of the different variables can be displayed on the same graph. Thus, relevant comparisons can be performed.
4) Results of an experiment can be analyzed in a very short time. Computers may complement the shortcomings of the laboratory applications that may arise from insufficient space in a timetable.

The differences between digital experiment tools and traditional experiment are shown in Figure I.

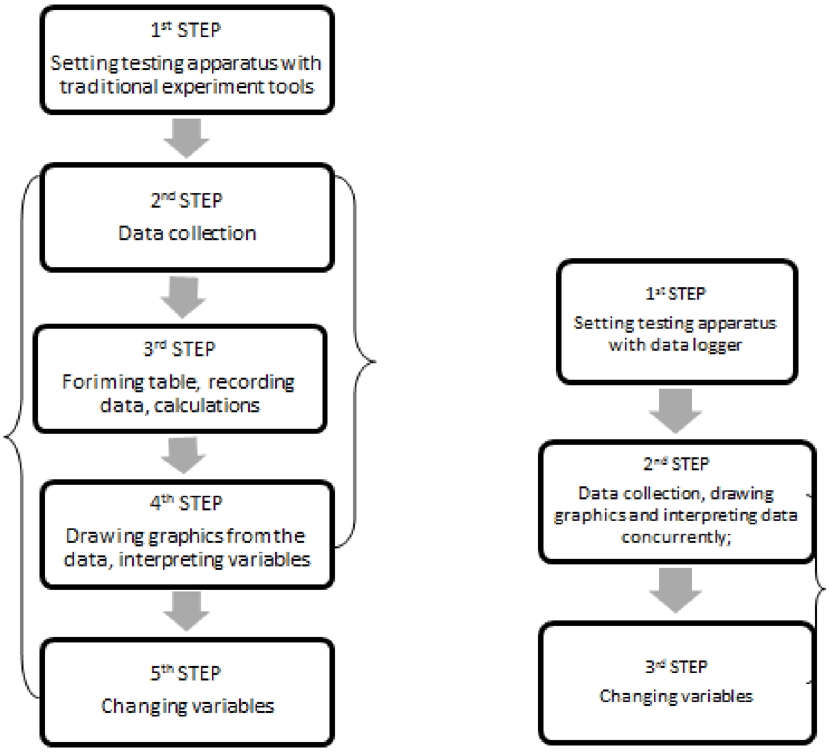

Figure 1. Showing the differences between traditional and digital experiments

The use of computer- based experiment tools in biology laboratories seems to have many benefits (Cakir&Dogan, 2015). Studies have shown that computer-based laboratory applications increase the learners' self-confidence and motivation; create a safe environment for learning; allow for group work; overcome the time constraint; use a structured education program; encourage cooperative learning; improve high level skills and keep students active (Cakir, 2011; Riza, 1997; Senemoglu, 2001; Usun, 2000; Hancock and et.al., 2002).

One of the notable benefits of laboratory applications is self-efficacy belief, which could encourage the use of laboratory activities more frequently in the classroom. Self-efficacy is defined as people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events affecting their lives (Bandura, 1986). Thus, this research aims to describe the advancement of students' laboratory utilization and the laboratory skills during their academic career.

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2. Purpose

The aim of this research is to determine the effects of computer-based biology laboratory experiments on the students' attitudes towards teacher self-efficacy, laboratory classes, and their perception of self- efficacy on the laboratory use. Thus, it aims to explore following research questions:

1) What is the effect of the laboratory activities implemented with the digital experiment tools on the students' perceptions of teacher self-efficacy?

2) What is the effect of the laboratory activities implemented with the digital experiment tools on the students' attitudes towards the laboratory classes?

3) Do the activities performed with the digital experiment tools have an effect on students' self-efficacy on the use of laboratory?

3. Method and material

3.1. The place and time of the study

This research was conducted by using the digital experiment tools with students in Gazi University. The application lasted for 6 weeks. Students were carried out their experiments such as cellular respiration, photosynthesis, determination of organic materials, physiology via digital experiment tools in groups. They used the appropriate sensor for the experiment then did the measurement for the results. After all the process completed they reported their results and discussed with other groups.

3.2. Population and sample selection

The researchgroup consisted of 28 voluntary students, who were studying biology education.

3.3. Model of the study

This research was designed according to the single group pretest - posttest model, as the experimental design (Karasar, 2006). The independent variable was applied to a group, which was randomly selected in the one single group pretest-posttest model. Both the pre-experimental (pre-test) and post- experimental (post-test) measurements were carried out. The symbolic view of the model is as follows:

G_1	$O_{1.1}$	X	$O_{1.2}$

G_1: research group, $O_{1.1:}$ first measurement (pre-test), X: independent variable (Educational activity) $O_{1.2:}$ second measurement (post-test)

When $O_{1.2} > O_{1.1}$ is the case in the model, this is considered to stem from X application (educational activity) and evaluated accordingly. In the research, quantitative data were obtained to support the intervention effect of using the computer-based biology applications like as digital tools. This research includes a research model considered as an alternative. Research method, which is considered as alternative, is quite useful in terms of investigating personal reactions that affect research results (Tashakkori & Teddlie, 1998).

3.4. Data Collection Tools

In this research, data were collected by using three different tools:

1) Teacher Self-Efficacy Scale;

2) Laboratory Attitudes Scale;

3) Laboratory Self Efficacy Scale.

In this research, "Teacher Self-Efficacy Scale", prepared by Tschannen-Moran & Hoy (2001), was used. In order to adopt this scale in the Turkish school, its validity and reliability were tested by the methods presented in Capa, Cakiroglu & Sarikaya (2005). The scale, which is a 9-point Likert scale, contains 24 items. The scale has 8 items were on the student engagement level; 8 items on the level for instructional strategies; and 8 items on classroom management level. The highest score that pre-service teachers can get from the scale is 216.00 (24x9), while the lowest score is 24.00 (24x1). The distribution of the scores on the scale is given in Table 1.

Table 1: Teaching self-efficacy scale score distributions

1	2	3	4	5	6	7	8	9 (score)
|	|	|	|	|	|	|	|	|
24	48	72	96	120	144	168	192	216 (Total score of 24 items of the scale)

The Cronbach Alpha Reliability Coefficient, calculated by Capa, Cakiroglu & Sarikaya (2005), was found as .93 for the overall scale; .82 for student engagement dimension; .86 for the dimension of instructional strategies; and, .84 for classroom management dimension. Within this research, the Cronbach Alpha Reliability coefficient was calculated as .942 for the overall scale; .838 for student engagement dimension; .866 for the dimension of instructional strategies; and, .870 for class management dimension.

The Laboratory Attitude Scale, developed by Ekici (2002), has three dimensions: ~~as~~ enjoyment, confidence and importance. Cronbach Alpha was calculated as 0.90, 0.80, and 0.72, respectively for the three dimensions of the scale, which has 21 items. Cronbach Alpha reliability was calculated as 0.93 for the whole scale.

The Laboratory Self Efficacy Scale developed by Ekici (2009) consists of two dimensions: personal factors and external factors). While the first dimension has 8 items, the second has 10 items. The Cronbach- Alpha reliability was found as 0.90 for the whole scale.

3.5. Analyses of datum

The analyses of the quantitative data were carried out using SPSS 20 program. The descriptive statistics, normality test, t-test and Wilcoxon signed rank test were used for the dependent groups.

4. Findings

The Students' teacher self-efficacy means score was 176.10. The pre-test mean score was 163.32. The students' post-test score increased descriptively, compared with their pre-test scores (Table 1).

Table 1. Pre-test and post-test descriptive statistics of teaching self-efficacy scale

	n	Min	Max	$\overline{X}$	sd
Pre-test	28	82	201	163.32	24.67
Post-test	28	82	205	176.10	25.91

The normal distribution of the data was examined in order to determine whether this difference is statistically significant or not.

When Table 2 was examined, the pre-test and post-test scores of students' teaching self-efficacy scale did not show a normal distribution ($p<.05$). That is why non-parametric Wilcoxon signed rank test was applied, and the findings were presented in the following table.

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Table 2. Pre-test and post-test normal distribution values of the teacher self-efficacy scale

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistics	**df**	**p**	**Statistics**	**df**	**p**
Pre-test	.138	27	.187	.917	27	.029*
Post-test	.136	27	.197	.839	27	.001*

p<.05

According to Table 3, the results of the Wilcoxon Signed Rank test indicated that the differences between the pre-test and post-test scores of the students' teacher efficacy scale were significant in favor of the post-test applications at the 0.05 level (pre-test of teacher self-efficacy scale $\bar{X}$ =163.32, SD =24.67; post-test $\bar{X}$ =176.10, SD =25.91). After the computer-based biology laboratory applications, the students' teaching self-efficacy perception scores were statistically higher than before the application. At the end of the research, the students' teacher self-efficacy perception levels have increased significantly. These results suggest that this research is of effective in terms of teacher-self efficacy perception levels.

Table 3.Wilcoxon Signed Rank test for pre-test and post-test scores of teaching self-efficacy scale

		n	Mean Rank	Sum of Ranks	Z	p
Post-test- Pre-test	**Negative rank**	5	4.60	23.00	-3.755	.001*
	Positive rank	20	15.10	302.00		
	Equal	3				
	Total	28				

p<.05

The students' pre-test mean scores of laboratory attitude scale were 89.21, while the mean post-test scores were 91.28. According to these results, the students' post-test scores have increased descriptively compared to the pre-test scores (Table 4).

Table 4. Descriptive statistics regarding pre-test-post-test of laboratory attitude scale

	n	Min	Max	$\bar{X}$	sd
Pre-test	28	79.00	101.00	89.21	6.17
Post-test	28	68.00	100.00	91.28	6.42

The normal distribution of the data was examined in order to determine whether this difference was statistically significant.

Table 5. Pre-test-post-test normal distribution values of Laboratory Attitude Scale

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistics	**df**	**p**	**Statistics**	**df**	**p**
Pre-test	.122	27	.200	.962	27	.390
Post-test	.134	27	.200	.870	27	.002*

p<.05

When Table 5 was examined, the students' teacher self-efficacy scale pre-test data showed a normal distribution, but the post-test scores did not show a normal distribution. ($p<.05$) Thus, to determine the differences, non-parametric Wilcoxon signed rank test was applied, and the findings are presented in Table 6.

The results of the Wilcoxon Signed Rank test showed that the difference between the pre-test and post-test scores of the students' laboratory attitude scale was not statistically significant at the 0.05 p-level. (Laboratory attitude scale pre-test $\bar{X}$ =89.21,SD =6.17; post-test $\bar{X}$ =91.28, SD =6.42). At the end of the computer-based biology laboratory applications, the students' laboratory attitude scores were descriptively higher than pre-test levels. However, this descriptive difference was not statistically different.

Table 6. Wilcoxon Signed Rank test for pre-test and post-test scores of laboratory attitude scale

		n	Mean Rank	Sum of Ranks	Z	p
Post-test- Pre-test	**Negative Rank**	8	10.50	84.00	-1.889	.059
	Positive rank	16	13.50	216.00		
	Equal	4				
	Total	28				

While the students' pre-test mean score of Laboratory self-efficacy scale was 74.75, the post-test mean score was 77.39. According to these results of the research, students' post-test scores have increased descriptively (Table 7).

Table 7. Descriptive statistics for pre-test-post test of Laboratory Self-efficacy scale

	n	Min	Max	$\bar{X}$	sd
Pre-test	28	62.00	88.00	74.75	6.11
Post-test	28	61.00	89.00	77.39	7.00

The normal distribution of the data was examined in order to determine whether this difference is statistically significant or not (Table 8).

Table 8. Pre-test and post-test normal distribution values of Laboratory self-efficacy scale

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistics	**df**	**p**	**Statistics**	**df**	**p**
Pre-test	.102	27	.200	.984	27	.939
Post-test	.114	27	.200	.972	27	.632

The students' pre-test and post-test scores of laboratory self-efficacy scale showed a normal distribution ($p >.05$). For this reason, t-test, one of parametric tests for dependent groups was applied to determine the difference, and the findings are presented in Table 9.

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Table 9. T-test results for dependent groups according to pre-test-post-test scores of laboratory self-efficacy scale.

	n	$\overline{X}$	sd	df	t	p
Pre-test	28	74.75	6.11	27	-2.08	.047*
Post-test	28	77.39	7.00			

p<.05

The t-test results for dependent groups showed that the difference between the pre-test and post-test scores of the students' laboratory self-efficacy scale was significant in favor of the post-test application at the 0.05 level ($t_{(27)\ \text{laboratory self-efficacy}}$ -2.08, $p<.05$). At the end of the research, the students' laboratory self-efficacy scores were statistically higher than the pre-test scores. As a result of the computer-based biology laboratory applications, the students' laboratory self-efficacy perceptions for the use of laboratories have increased significantly. These results revealed that this research was effective in terms of students increasing self-efficacy for the use of laboratories.

5. Result and Discussion

When similar studies were examined, the use of digital experiment tools for laboratory is an effective tool in science education (Cakir&Dogan, 2015). Newton (2000) revealed the benefits of data recorder applications in secondary schools in England. Rogers and Wild (1996) explored students' views after data recorder applications. At the end of the applications, the students who used the digital experiment tools showed improvement with time–management had enough time to interpret and discuss data without difficulty, and etc. Their observations skills improved, the quality of the measurements developed, the operation of data was carried out easily, and the students could re-do the experiments in a short time.

Kennedy and Finn (2000) also showed that the data recorders were quite effective in science laboratories at schools, as they enabled many experiments to run smoothly in Ireland. For instance, the results of these experiments were recorded with reliability, and facilitated the teaching of difficult scientific concepts. Aydın (2005) suggested that the group that carried out experiments with the digital experiment tools became more successful when compared to the control group. Also, the interview results showed that the digital experiments engaged the students' attention and provided opportunities for meaningful learning. Boniec and et al. (2011) examined the effect of data recorders on learning and teaching in science courses, and they concluded that the participants' understanding of science and applying the scientific methods improve.

The use of technology in science education creates more effective, long-lasting, and enjoyable learning environment. The use of computer-based biology experiments created both an effective and joyful learning environment for students – an environment that the traditional method of science teaching could not have achieved (Cakir, 2011). Rodrigues, Pearce and Livett (2001) conducted various experiments to determine first-graders' understanding of scientific concepts through the use of computer-based digital experiment tools in Australia and thus, applied the data logger (i.e., data recorders). At the end of the research, they suggested that the students enjoyed doing the experiments and understood the concepts in a constructivist fashion. As such, it is vital that the pre-service teachers should learn to integrate the latest technological advances into the science classroom, in order to meet the needs of the new age coming ahead, before they graduate from their teacher preparation programs. Upon graduating, the teachers should then be able to create a unique learning environment in which their students can also experience the benefits of using technology in the science classrooms. Yilmaz (2007) highlighted that the teachers who educate the individuals for matters concerning our societal needs must know how to integrate technology in their science classrooms. To this end, computer-based applications can contribute to the success of both the students and teachers alike.

When Pektas and et.al (2006) examined the effect of computer-based education in science courses, the experimental group using thecomputer- based program was found to be more successful when compared to the control group. Thornton and Sokoloff (1998) employed computer-based digital experiment tools to teach the scientific concepts in physics classes and found the program to be successful. They concluded from the research that the experimental group understood the topic better than the comparison group.

Attitude is a behavior that is resistant to change and needs to undergo a process to be changed (Ekici, 2002). It is assumed that students' attitudes did not change in this current research, since the computer-based laboratory applications with digital experiment tools were not implemented for a long time. Similarly, when Yigit and Akdeniz (2003) examined the effect of computer-based activities on students' attitudes in physics education, they did not find a significant difference in the students' attitudes before and after the research.

Considering the positive effects of the computer-based digital experiment tools in the biology laboratory applications, and the positive influence of the data recorders, the authors of this study posit that this technological integration has been an important aspect of the students' science learning experience, and has positively contributed to the development of students' self-efficacy, success, and perception towards laboratory courses.

The following suggestions may be presented according to the results obtained from the study.

1. The study can be performed with larger groups using different experimental designs,
2. Longitudinal studies can be carried out to enhance students' laboratory self-efficacy,
3. More self- study opportunities can be provided by increasing the number of devices used in the computer-based biology laboratories,
4. The effects of computer-based biology laboratory experiments on the learning environment outside the classroom can be investigated,
5. The effects of computer-based laboratory experiments on students' cognitive levels can be examined,
6. Studies about the feasibility of computer-based biology laboratory devices at schools can be carried out in a descriptive model.

6. Conclusions and recommendations

This research revealed how the students' attitudes towards teacher self- efficacy, laboratory classes, and their self-efficacy of using laboratories changed after the computer-based biology laboratory applications with digital experiment tools.

Self-efficacy is defined as "a feature that is effective in the form of behavior and personal judgment of one's capabilities to organize and conduct required activities in order to attain a certain performance successfully" (Bandura, 1995; Zimmerman, 1995). *Perceived self-efficacy* is referred as "one's belief in their capacities of mobilizing motivation, knowledge sources and actions according to demands of the given situation" (Wood and Bandura, 1989,). In this context, the use of the laboratory can be considered as the perceived self-efficacy, while one's own judgment of using laboratories appropriately can be perceived as the self-efficacy (Ekici, 2009). In this sense, that students' self- efficacy on the use of the laboratories were presented before and after the implementation of the digital tools.

The results showed that at the end of the computer -based biology laboratory applications with digital experiment tools, the difference between students' pre-test and post-test scores of teacher self-efficacy scale was significant in favor of the post-test applications at the 0.05 level. The Students' post-test scores of teacher self-efficacy scale were higher than pre-test scores. This suggested that this research is effective in terms of teacher self-efficacy perception levels. In addition, the difference between the same students' pre-test and post-test scores of laboratory self-efficacy was examined, and the result was found to be significant in favor of the post-test at the 0.05 level. As a result of computer-based biology laboratory applications, the students' self-efficacy for the use of laboratories increased significantly. This result showed that this research is effective to increase self-efficacy for the use of laboratories.

According to Allport (1935), *attitude* is emotional and mental preparedness which results from life and experiences, and which has a leading or dynamic influence on one's behavior towards the objects or situations in which she is interested (Guven and Uzman, 2006). When students' pre-test and post-test scores of laboratory attitude scale were examined, the mean was in favor of post-test, but the difference did not show significance at 0.05 levels.

References

Alkan, C. (1988). Bilgisayar destekli öğrenme modülleri [Computer-based Learning Modules]. *A. Ü. Eğitim Bilimleri Fakültesi Dergisi, 21,* 255-263.

Ayas, A., Cepni, S. &Akdeniz, A.R. (1994).Fen Bilimleri Eğitiminde Laboratuvarın Yeri ve Önemi [The Role and Importance of Laboratory in Science Education]. *Çağdaş Eğitim Dergisi,* 205, 7-11

Aydin, M. (2005).Bütünleştirici öğrenme kuramına uygun bilgisayar destekli dijital deney araçları ile fen laboratuvar deneyleri tasarlama ve uygulama [Design and implementation of science laboratory activities using data logger and constructivist laboratory approach] *Karadeniz Teknik Üniversitesi Fen Bilimleri Enstitüsü* (Unpublished master's thesis).

Bandura, A. (1986). *Social foundations of thought and action: a social cognitive theory. Englewood cliffs,*NJ:Prentice-Hall.

Bandura, A. (1995). *Exercise of personal and collective efficacy in changing societies. Self-efficacy in changing societies.* Cambridge University Press.

Boniec, M.L., Valazquez, A.G. & Joyce, A. (2011).*Impact of data loggers on science teaching and learning* .European Schoolnet (Eun Partnership Aisbl).

Capa, Y., Cakiroglu, J. & Sarikaya, H. (2005). The development and validation of a Turkish version of the teachers' sense of efficacy scale. *EğitimveBilim, 30(137):* 74–81.

Cakır, M. & Dogan, Ö. K. (2015).Teaching Mendelian genetics with a virtual Drosophila laboratory. *School Science Review*, 97(358), 10-15

Cakır, M. (2011).Enhancing Mendelian Genetics Concepts Using a Guided Computer-Mediated Inquiry.*Journal of Baltic Science Education, 10*(3), 156-167.

Ekici, G. (2002). Biyoloji öğretmenlerinin laboratuvar dersine yönelik tutumlarının farklı değişkenler açısından incelenmesi [Investigation of biology teachers' attitudes for laboratory courses in terms of different variations]. *V. Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi,* 22- 25 Eylül, ODTÜ, Ankara.

Ekici, G. (2009). Biyoloji öğretmenlerinin laboratuvar kullanımı öz-yeterlik algılarının incelenmesi [An examination of the biology teachers' laboratory self-efficacy perceptions]. *Ahi Evran Üniversitesi Eğitim Fakültesi Dergisi, 10(3)*, 25-35.

Gul, S. & Sozbilir, M. (2015). Biology education in research trends in Turkey. *Eurasia Journal of Mathematics, Science & Technology Education, 11*(1), 93-109.

Guven, B. &Uzman, E. (2006).Ortaöğretim coğrafya dersi tutum ölçeği geliştirme çalışması [The development of scale for secondary geography course attitude]. *Kastamonu Eğitim Fakültesi Dergisi, 14*(2), 527-536.

Hancock, D. R., Bray, M., &Nason, S. A. (2002).Influencing university students' achievement and motivation in a technology course.*The Journal of Educational Research, 95*(6), 365-372.

Karasar, N. (2006). *Bilimsel Araştırma Yöntemi [Scientific Research Method].* Ankara: Nobel Yayınevi, Ankara.

Kennedy, D., & Finn, S. (2000). The use of datalogging in teaching physics and chemistry in second-level schools in Ireland. *The Natıonal Centre For Technology In Educatıon And The Department Of Educatıon And Scıence,* University College Irish Science Teachers' Cork

Association.Newton, L. R. (2000). Data-logging in practical science: research and reality. *International Journal of Science Education, 22(12)*, 1247-1259.

Ng, P., & Yeung, Y. (2002).*Implications of data-logging on physics experiments: A preliminary study, ınnovate ideas in science teaching theories and examplars.* The Hong Kong Institute of Education, Hong Kong.

Olgun, M. P. (2001). Okul Öncesi eğitim kurumlarında çalışan eğitimcilerin bilgisayar destekli eğitim hakkındaki görüş ve tutumlarının incelenmesi [Understanding preschool teachers thoughts and attitudes toward computer assisted introduction]. Hacettepe Üniversitesi, Ankara (Unpublished Master's Thesis).

Pektas, M., Turkmen, L. & Solak, K. (2006). The effect of computer assisted instruction in the learning of urinary system and digestıve system units for the science teacher candidates. *Kastamonu Eğitim Fakültesi Dergisi, 2*: 465-472.

Riza, E. T. (1997). *Eğitim teknolojileri uygulamaları [Educational Technology Practices]*. Anadolu Matbaası, İzmir.

Rodrigues, S., Pearce, J., & Livett, M. (2001). Using video analysis or data loggers during practical work in first year physics. *Educational Studies,* 27(1), 31-43.

Rogers, L., & Wild, P. (1996). Data-Logging: EfffectsOn Practical Science. *Journal of Computer Assisted Learning, 12* (3), 130-145.

Senemoglu, N. (2001). *Gelişim öğrenme ve öğretim* [*Development of learningandteaching]*. Gazi Kitapevi, Ankara.

Sonmez, V. (2004).*Öğretmen el kitabı.[Teachers' Handbook]*. Anı Yayınları, Ankara.

Tashakkori, A., & Teddlie, C. (1998). *Mixed methodology: Combining qualitative and quantitative approaches.* London: Sage Publication.

Tezbasaran, A. A. (1997). Öğretim ve Öğrenmede Bilgisayara Dayalı Bilgi Teknolojileri [Information Technologies of Computer-based Learning and Teaching]. *Bilim Teknik Dergisi, 355, 54-55.*

Thornton, R., & Sokoloff, D. R. (1998).Assessing student learning of Newton's law: The force and motion conceptual evaluation and the evaluation of active learning laboratory and lecture curricula.*American Journal of Physics*, 664, 338-352

Usun, S. (2000). *Dünya'da ve Türkiye'de bilgisayar destekli eğitim [Computer-based Learning in the World and Turkey]*. İstanbul: Pegem A Yayıncılık.

Wood, R. E. & Bandura, A. (1989).Effect of perceived controllability and performance standards on self-regulation of complex decision-making.*Journal of Personality and Social Psychology, 56*(5), 805–814.

Yager, R. E. (2000). A vision for what science education should be like for the first 25 years of a new millenium. *School Science and Mathematics, 100(6),* 327-342.

Yaman, M. & Soran, H. (2000). Türkiye'de ortaöğretim kurumlarında biyoloji öğretiminin değerlendirilmesi [Evaluation of secondary education in biology teaching in Turkey]. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi,18*, 229–237.

Yılmaz, M. (2007). Sınıf öğretmeni yetiştirmede teknoloji eğitimi. [Technology education for class teacher training]. *Gazi Eğitim Fakültesi Dergisi, 27(1),* 155-167.

Yigit T, N. & Akdeniz, A. R. (2003). The effect of computer-assisted activities on student achievement in physics course: electric circuits sample. *Gazi Eğitim Fakültesi Dergisi, 23(3),* 99-113.

YOK/Dünya Bankası Milli Eğitim Geliştirme Projesi, Öğretmen Eğitimi Dizisi. (1997*). İlköğretim fen öğretimi.* Ankara.[YOK/World Bank National Education Development Project, Teacher Training Series.Primary science education.]

Zimmerman, B. J. (1995). Self-efficacy and educational development. In (Ed. A. Bandura) *Self-efficacy in changing societies* (pp.202-231). New York: Cambridge University Press.