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Investigating the Effect of Using Web 2.0 Tools on 7th-Grade Students' Academic Achievements in Science and Self-Directed Learning with Technology

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ABSTRACT
This study aims to investigate the effect of course activities carried out using web 2.0 tools in the "Interaction of Light with Matter" unit in the Science Course on the academic achievements and self-directed learning levels of 7th-grade students. For this purpose, the model of the research was determined as a pretest-posttest control group quasi-experimental design. As the data collection tools, the Academic Achievement Test for the Interaction of Light with Matter developed by the researcher and the Self-Directed Learning with Technology Scale for Young Students were used. According to the findings obtained from the research, it was determined that the lesson activities prepared using web 2.0 tools positively affected the academic achievement of the students in the experimental group and their self-learning levels with technology. It can be said that the significant difference between the academic achievement posttest scores of the experimental and control groups is due to the higher effect level of applications of the web 2.0 activities in the experimental group on achievement. It was determined that gender did not have a significant effect on the academic achievement and self-learning levels of the students in each group.

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Introduction

The rapid involvement of computer technologies in education in recent years allows teachers to bring interesting activities that can be developed with these technologies into the classroom environment. Web 2.0 tools are one of the educational technologies that students can work in collaboration with (Solomon & Schrum, 2014). Web 2.0-based technologies have the potential to both improve and transform the learning environment and to make learning more interesting, more meaningful, and more original. Using Web 2.0 tools and other technologies can increase students' motivation and academic success towards the course (Wankel & Blessinger, 2013). The use of social web tools makes it easier for teachers to interact with students while improving collaboration skills among students. (Molinillo et al., 2018). Thanks to Web 2.0 tools, teachers from different parts of the world can create collaborative projects together and share these projects in web environments accessible to everyone. Web 2.0 tools are exciting environments designed to improve participants' content creation and sharing skills (Griffin & Ramachandran, 2010). Web 2.0 technologies help not only students' cognitive learning, but also effective learning and social learning that appeal to students' self-learning skills (Wankel & Blessinger, 2013). Most web 2.0 technologies increase collaborative learning and allow students to work together or compete with each other on projects

(Harris & Rea, 2009). Web 2.0 technologies provide real learning experiences for students and promote global awareness, creativity, innovation, critical thinking, active participation, and collaboration (Crane, 2012; Prandini & Ramilli, 2012; Cych et al., 2018). Web 2.0 tools with rich content have positive effects on learning (Caliskan et al., 2019). Social networks, blogs, microblogs, wikis, podcasts, vodcasts, Google tools, virtual environments, collaboration tools, mobile applications, video sharing tools, and more are examples of web 2.0 tools (Crane, 2012; Solomon & Schrum, 2014). Besides these examples, there are many web 2.0 technologies that can be used in educational environments.

Web 2.0 technologies provide teachers and students with many opportunities that can be used in the classroom environment. In classrooms where Web 2.0 technologies are used, students' social connection ability, the ability to collaboratively explore and share information, the ability to create content, and the ability to collect and rearrange information develop (McLoughlin & Lee, 2007). Using Web 2.0 technologies in the classroom enables students to use new research methods and improve their contemporary digital literacy (Crook & Harrison, 2008). In a recent study, web 2.0 technologies were included in the classification of personal learning environments. In personal learning environments, students can work individually, as well as communicate and interact with their peers (Lim & Newby, 2020).

It is conceivable that Web 2.0 technologies, when used for collaboration in the classroom, can affect learning. Topalcengiz and Yıldırım (2020) In their research have reported that Web 2.0 technologies improve creativity, knowledge sharing, and collaboration between students-students and students-teachers. Although there are many studies with adult students and teachers on the use of Web 2.0 tools in education, it is striking that the number of Web 2.0 studies with young students or children is low in science education. Considering that studies on the use of Web 2.0 tools in educational environments are still in the early stages, and studies on their use in science education are limited in the literature, the use of Web 2.0 technologies in educational environments has been seen as an issue worth examining. In this research, in order to understand how the classroom climate will be affected when these technologies are used and believing that it will create an opportunity for both teachers and students to improve themselves, the use of web 2.0 tools in the unit of "Interaction of Light with Matter" on the academic achievements and self-directed learning levels of 7th-grade students was investigated. For this purpose, the following questions were asked;

1. Do lesson activities prepared using Web 2.0 tools have a significant effect on students' academic achievement scores in science?

2. Are the academic achievement in science posttest scores of the students in the experimental and control groups affected by gender?

3. Do the lesson activities prepared by using web 2.0 tools have a significant effect on the scores of the self-directed learning with technology (SDLT) scale?

4. Are the posttest scores of the SDLT scale affected by the gender of the students in the experimental and control groups?

Methods

In this research, a pretest-posttest control group quasi-experimental design was employed. In the pretest-posttest control group quasi-experimental design, there are two groups- one of them is experimental and the other takes place as the control group. Measurements are made before and after the experiment under equal conditions in both groups (Karasar, 2018, p.132).

In the experimental process of the research, the experimental procedure was carried out after pre-tests were applied to both groups. Finally, posttests were applied to both groups and the research was completed. As seen in Table 1, while the activities envisaged in the program were supported by web 2.0 tools in the experimental group, the course was taught with the activities envisaged in the program in the control group. The Interaction of Light with Matter Academic Achievement (ILMAA) test was applied to the experimental and control groups as a pre-test at the beginning of the study, and the SDLT scale was applied to both the experimental group and the control group as a post-test at

the end of the study. In addition, lesson plans and activities were prepared by the researcher in the experimental group. Lesson plans and activities prepared for the experimental group were supported by appropriate web 2.0 tools. Experimental procedures of the research were carried out for seven weeks, and the pretest and posttest applications were completed in nine weeks.

Table 1

Experimental Design of The Research

Groups	Pretest	Experimental procedure	Posttest
Experimental Group	*ILMAA test **SDLT scale	The activities seen in the program were processed supported by web 2.0 tools in the classroom environment.	ILMAA test SDLT scale
Control Group	ILMAA test SDLT scale	Lessons were taught with the activities for seen in the program in the classroom.	ILMAA test SDLT scale

*ILMAA test: Interaction of Light with Matter Academic Achievement test
**SDLT scale: Self-Directed Learning with Technology scale

Sampling

This research was conducted in two public secondary schools in Izmit, Kocaeli, in the second semester of the 2018-2019 academic year, after obtaining the necessary permissions. One of the schools is the school where the researcher performed the experimental procedures. Due to the length of the research process and the intensity of pre-lesson preparations, the school where the researcher was located was determined as the experimental group. The control group, on the other hand, was chosen from a different secondary school with a similar infrastructure and success level to the school where the experimental group was located. While deciding that the schools are at an equal success level, students' LGS exam results and science course achievements were taken into account. The research was conducted with a total of 84 seventh-grade students in the experimental and control groups. Before the experimental process, in order to select the groups to be included in the research and determine their equivalence in terms of academic achievement, technology, and self-directed learning points were taken as prerequisites for sample selection. To determine whether the pre-test scores of Interaction of Light with Matter Academic Achievement (ILMAA) test and the Self-Directed Learning with Technology for young students (SDLT) scale of the experimental and control groups to participate in the study were equivalent, the t-Test for Unrelated Samples was conducted. Analysis results are given in Table 2.

Table 2

Analysis of The Test and Scale Pretest Scores of The Groups

Test/ Scale	Groups	N	$\bar{x}$	sd	df	t	p
ILMAA test	Experimental	45	8,6	2,65	82	-1,395	,167
	Control	39	9,4	3,16			
SDLT scale	Experimental	45	3,49	,69	82	-1,300	,197
	Control	39	3,67	,61			

When Table 2 is examined, it is seen that there is no significant difference between the ILMAA test and the SDLT pre-test scores of the students in the experimental and control groups ($t_{(82)}$=-1.395, p>.05; $t_{(82)}$=-1,300, p>.05). In this case, it was determined that the ILMAA test and the SDLT pre-test scores of the students in the experimental and control groups were equivalent to each other.

The demographic characteristics of the students in the research group are given in Table 3.

Table 3

Demographic Information of The Students in The Research Group

Schools	Grade	Groups	N		
			Girls	Boys	Total
A	7	Experimental	17	28	45
B	7	Control	20	19	39

When Table 3 is examined; it is seen that the research was conducted with seventh-grade students selected from two different schools. The schools included in the study were determined by the convenience sampling method, one of the purposeful sampling methods because the research process was long, the researcher carried out the lesson activities in the experimental group, and technical infrastructure was needed in the conduct of the lesson activities. The convenience sampling method brings speed and practicality to the research. Because, in this method, the researcher chooses a situation that is close and easy to access (Yıldırım & Şimşek, 2016, p.123). The reason for choosing the experimental and control groups from two different schools in the study is to ensure that the students in the control group are not affected by the experimental procedures. In order to keep the teacher's attitudes under control, no observations were made in the control group, but intensive communication was provided with the teacher conducting the lesson in the extracurricular environment, and mutual information was provided to conduct lesson activities and tests in an unbiased manner. The fact that the teachers in the experimental and control groups have graduated from the same education faculties, that their experiences are similar and their schools have similar characteristics in terms of both social environment and level of success are the qualifications that support the similarity of teacher attitudes.

Data Collection Instruments

The Interaction of Light with Matter Academic Achievement (ILMAA) is a twenty-question test developed by the researcher, which is used as a pretest and posttest to measure student achievement on the subjects covered by the seventh grade "Interaction of Light with Matter" unit. While the test was being developed, a table of specifications was prepared by analyzing the acquisitions in the unit according to the cognitive domain levels. In this way, it was determined whether the questions in the measurement tool represent the subjects to be measured in a balanced way. After creating the statement table, question banks, textbooks, and questions from the previous years were examined, and a question pool containing all the gains in the unit was created. Considering the lesson time allocated for each subject and the number of acquisitions within the scope of that topic, a total of 40 multiple-choice questions were prepared, including 20 questions first and then one substitute question for each question in this test. The measurement tool developed as an achievement test consists of 20 questions. The reason for preparing questions twice the targeted number of questions is that in case of any question that needs to be removed, it is requested to maintain the validity of the content. The prepared 40-question trial form was examined by 2 experts in the field of science education and 2 science teachers to determine the content and face validity. After corrections were made in line with a few warnings, the validity and reliability studies of the test were initiated. The Interaction of Light with Matter Academic Achievement (ILMAA) test was applied to 428 eighth-grade students in three secondary schools in Izmit, Kocaeli, in order to examine the validity and reliability. The reason why the practice is carried out with eighth graders; It represents the group that learned the unit "Interaction of Light with Matter" most recently.

The KR-20 reliability coefficient was calculated as 0.77 using Microsoft Excel Program. Another way to determine the reliability coefficient is the Cronbach α method. This method is the most well-known reliability calculation method and it is based on estimating the reliability by looking

at the compatibility of the items with each other (Başol, 2016). Based on this information, the reliability of the test was also examined with the Cronbach α method. The Cronbach Alpha reliability coefficient of the ILMAA test was calculated as 0.76. The students were given 40 minutes to apply the test as a pretest and posttest to the research group. The reliability coefficient was calculated again for the groups to which the posttest was applied, and the KR-20 value was calculated as 0.72, alpha reliability coefficient 0.78.

The self-directed learning with Technology for Young Students (SDLT) scale, developed by Teo et al. in 2010 and adopted to Turkish by Demir and Yurdugül (2013), was used as another data collection tool. The "Self-Learning with Technology for Children (SDLT) scale used in the study was developed by Teo et al., in 2010. The adaptation study of the scale into Turkish was conducted by Demir and Yurdugül (2013). The original scale and the Turkish form of the scale were found to be exactly the same in terms of the item factor structure. In other words, the scale consists of 6 items in total, consisting of two factors of 2 and 4 items, and the Cronbach Alpha internal consistency coefficient of the scale was calculated as 0.72 in total. In this study, the post-test reliability Cronbach's Alpha internal consistency coefficient was calculated as 0.77.

Experimental Process

For this research, necessary permissions were obtained from the Kocaeli Provincial Directorate of National Education in order to carry out the research with seventh-grade students in their Science course at two secondary schools in Izmit. Since the experimental process of the research and the teaching program to be used in the research were structured by the researcher, the lesson plans and activities of the experimental group were prepared. Lesson plans and activities prepared for experimental groups were arranged in accordance with Web 2.0 tools. Each lesson plan was planned in line with the gains in the Science Education Program and the activities have been created for these skills and gains. For the control group, prior to the start of the unit, the science teacher conducting the course was interviewed and a commitment was made to ensure that the subjects and activities included in the program were carried out completely.

Considering that the students had not been familiar with web 2.0 tools before and these applications require technological skills, preliminary information was needed. This information was provided by the researcher. Before starting the "Interaction of Light with Matter" unit in the experimental and control groups, ILMAA test and SDLT scale pre-tests were applied. After the pre-tests were completed and the necessary information was given to the experimental group students, the experimental process was started. The application lasted nine weeks in both the experimental group and the control group. In this process, activities using web 2.0 tools prepared by the researcher were carried out in the experimental group. In the control groups, the activities in the curriculum were applied.

After the seven-week process in which experimental activities were applied, the final measurements were started. The last measurements were completed within a week. ILMAA test and SDLT scale were applied to the experimental and control groups as a posttest. The names of the activities applied to the students in the experimental group in the study, the achievements of the activities, and the number of class hours in which the activities were applied are given in Table 4.

Table 4

Activities Developed Using Web 2.0 Tools in The Experimental Group

Gain	Time	Activities Implemented in the Experimental Group
F.7.5.1.1. discovers that light can be absorbed by matter as a result of its interaction with matter.	2 class hours	Activity 1: Let's think, discuss and share with Padlet Activity 2: Let's guess, observe and explain with Edpuzzle, Activity 3: Let's Predict, Observe and Explain with Padlet Activity 4: Let's race with Plickers Activity 5: Let's write a science journal with Padlet
F.7.5.1.2. concludes that white light is a combination of all light colors.	2 class hours	Activity 6: Let's Explore with a Jigsaw puzzle Activity 7: Let's Write Our Ideas with Eba Activity 8: Let's Experiment with Algodoo Activity 9: Let's Guess, Observe and Explain with Eba Activity 10: Let's Race with Plickers Activity 11: Let's write a Science diary with Eba
F.7.5.1.3. associates the reason why objects appear black, white, and colored as a result of her observations with the reflection and absorption of light	2 class hours	Activity 12: Let's Think and Discuss with Eba Activity 13: Science with Eba Activity 14: Let's Experiment with Morpa Campus Activity 15: Let's Race with Plickers Activity 16: Let's Write a Science Diary with Eba
F.7.5.1.4. gives examples of innovative applications of solar energy in daily life and technology.	2 class hours	Activity 17: Let's Discover Innovative Applications of Solar Energy with Animaker Activity 18: Let's Learn with e-Stations. Activity 19: Let's Write a Conclusion with Eba Activity 20: Let's Build a Word Cloud with Wordart Activity 21: Let's write a Science diary with Eba
F.7.5.1.5. Discusses her ideas about how to benefit from solar energy in the future.	2 class hours	Activity 22: Let's Think, Discuss and Share with Eba Activity 23: Let's Design a Solar Furnace with Mini E-Design Steps Activity 24: Let's write a science journal with Eba
F.7.5.2.1. Gives examples of usage areas by observing mirror types.	2 class hours	Activity 25: Eba and I think in Science Language Activity 26: Let's design a poster with Postermywall Activity 27: Designing a Periscope with Algodoo Activity 28: Let's race with Kahoot! Activity 29: Let's write a science journal with Eba
F.7.5.2.2. Compares the images formed in flat, hollow, and bulged mirrors.	2 class hours	Activity 30: Let's Experiment with Eba Activity 31: Let's Think and Discuss With Eba Activity 32: Let's Guess, Observe and Explain with Edpuzzle Activity 33: Let's Explore Image Properties in Flat Mirror with Algodoo Activity 34: Let's Associate Words with Eba Activity 35: Let's Race with Quizizz Activity 36: Let's Write a Science Diary with Eba

Continuation of the Table 4

F.7.5.3.1. Relates the reason of refraction with the change of environment by observing the path of light changing the environment.	2 class hours	Activity 37: Let's Race with a Jigsaw puzzle Activity 38: Let's Think, Discuss, Share with Eba Activity 39: Let's Simulate with Morpa Campus Activity 40: Let's Experiment With Algodoo Activity 41: Let's Race with Kahoot Activity 42: Let's Write a Science Diary with Eba
F.7.5.3.2. Observes the refraction of light by experiment using thin and thick rim lenses. F.7.5.3.3. Determines the focal points of thin and thick-edged lenses by testing.	4 class hours	Activity 43: Let's Improve Views with Google Docs Activity 44: Let's Solve Problems with Edrawmax Activity 45: Getting to Know the Lenses with Morpa Campus Activity 46: Let's Discover the Lenses with Algodoo Activity 47: Let's Interpret What We Learned with Eba.Activity 48: Let's write a Science diary with Eba
F.7.5.3.4. Give examples of the usage areas of lenses in daily life and technology.	2 class hours	Activity 49: Let's Explore the Lens with Powtoon Activity 50: Let's Learn with e-Stations Activity 51: Let's Compete with Plickers Activity 52: Let's Build a Word Cloud with Wordart Activity 53: Let's write a science diary with Eba
F.7.5.3.5. Designs an imaging tool using mirrors or lenses. First of all, he /she is asked to express his design with a drawing. If suitable, they may be asked to convert it to a three-dimensional model.	2 class hours	Activity 54: Let's Design a Galileoscope and Keplerscope with Mini e-Design Activity 55: Let's write a science diary with Eba

Students carried out activities prepared by the researchers using their own personal computers and different Web 2.0 tools. During the activities, active learning techniques were used by the students for their own learning, and it was emphasized that the students shared with their group friends. After each activity, the products prepared by the student groups were shared in the classroom.

Data Analysis

The analysis of the data collected in the study was done through the SPSS 22 package program, and the statistical methods and techniques used in the process are given in Table 5. Examining Table 5, it can be seen by which method and technique the sub-problems of the research are analyzed.

Table 5

The Statistical Methods and Techniques Used in The Analysis of The Subproblems of The Research

Test and Scale	Subproblems	Analysis
Interaction of Light with Matter Academic Achievement (ILMAA) test and the Self-Directed Learning with Technology for young students (SDLT) scale	First subproblem	Two-way analysis of variance for repeated measures
	Second subproblem	Two-way analysis of variance for unrelated samples
Self-Directed Learning with Technology for young students (SDLT) scale	Third subproblem	Two-way analysis of variance for repeated measures
	Forth subproblem	t-test for unrelated samples

In addition, in determining the demographic characteristics of the students in the research groups, frequency values were used. Arithmetic mean and standard deviation values were used in the distribution of the scores the students got from the data collection tools. Cronbach Alpha internal consistency coefficient and KR-20 internal consistency coefficient were used to calculate the reliability coefficient of the scales used in the study. The Levene test was used to determine the homogeneity of the data obtained in the study, and the mode, median, peak values, and the coefficients of skewness and kurtosis were used to determine whether they showed normal distribution.

Findings

Findings Regarding the First Research Question

The first question of the study is "Do the course activities prepared using Web 2.0 tools have a significant effect on students' academic achievement?". Since the measurement results of the experimental and control groups were compared (measurement for unrelated samples) and the experimental or control groups were given a pretest and a posttest (repeated measurement), two-way analysis of variance was used for repeated measurements in order to answer this question. First of all, the skewness and kurtosis values of the experimental and control groups for four separate groups, namely ILMAA pretest and posttests, were placed in Table 6.

Table 6

The Skewness and Kurtosis Values of The Experimental and Control Groups for The IMEAB Pretest and Posttest Scores

Tests	Groups	Skewness	Standard error	Kurtosis	Standard error
ILMAA Pretest	Experimental	,31	,35	-,44	,69
	Control	-,19	,37	-,75	,74
ILMAA Posttest	Experimental	-,57	,35	-,74	,69
	Control	,03	,37	-,53	,74

If the coefficients of skewness and kurtosis are within the limits of -1, +1, it can be interpreted that the scores do not show a significant deviation from the normal distribution (Büyüköztürk, 2018, p.40). For this reason, when Table 6 is examined, it is seen that the skewness and kurtosis coefficients of the groups are within the -1, +1 boundaries, showing a normal distribution. Finally, according to the results obtained from the Levene test, it is stated in Table 7 that there is no difference between variances (p>.05), that is, the condition of equality of variances is met.

Table 7

ILMAA Pretest and Posttest Homogeneity Test Results

Tests	F	df1	df2	sig.
ILMAA Pretest	1,54	1	82	,21
ILMAA Posttest	2,87	1	82	,09

When the examinations made on the obtained data were evaluated, it was concluded that the necessary assumptions were met to make a Two-Way Analysis of Variance for Repeated Measures. Arithmetic averages and standard deviations of the academic achievement scores of the students in

the experimental and control groups before and after the application are calculated and given in Table 8.

Table 8

Descriptive Statistics Values Obtained from The ILMAA Test

Groups	Pretest			Posttest		
	N	$\bar{X}$	sd	N	$\bar{X}$	sd
Experimental	45	8,60	2,65	45	15,80	2,71
Control	39	9,48	3,16	39	11,87	3,86
Total	84	9,01	2,92	84	13,87	3,82

As seen in Table 8, in the experimental group where lessons were taught with web 2.0 tools, the pre-application academic achievement mean score was increased after the application (from $\bar{X}$=8.60 to $\bar{X}$=15.80). In the control group, where the course is taught according to the activities in the science curriculum, the academic achievement pretest and posttest mean scores are 9.48 and 11.87, respectively. Considering that the highest score to be obtained from this test is 20, it is seen that there is an increase in the academic achievement scores of the students in both the experimental groups and the control groups. Two-Way Analysis of Variance for Repeated Measures was applied to determine whether the change in the pretest-posttest scores of the experimental and control groups was statistically significant and the analysis results are given in Table 9.

Table 9

Two-Factor Analysis of Variance Results for Repeated Measures for ILMAA Test Scores

Source of Variance	Sum of Squares	df	Mean of Square	F	p	η^2
Group (experimental/control)	1,26	1	1,26	1,91	,17	-
Measurement (pretest-posttest)	,05	1	,05	,10	,74	-
Group * Measurement	5,43	1	5,43	10,56	,00	,11
Error	42,14	82	,514			

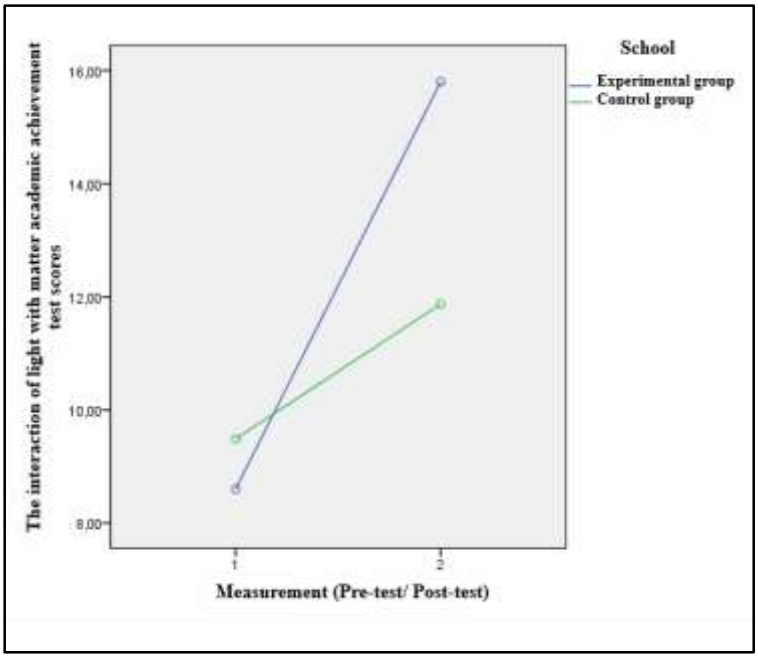
When Table 9 is examined, the group (experimental/control)-measurement (pretest-posttest) common effect, as a result of the Two-Factor Analysis of Variance for Repeated Measures performed to test whether being in the experimental or control group has a significant effect on test scores, showed that it was significantly more than the control group (F=46,93, p<,01). In this case, it can be concluded that using web 2.0 tools in the science course has a significant effect on increasing the academic achievement scores in the Interaction of Light with Matter unit. It is seen that this situation has a wide effect (η^2=,36).

Figure 1 shows the pre-test-post-test differentiation between the experimental group in which the activities performed using Web 2.0 tools and the control group in which the activities in the current curriculum were applied.

When Figure 1 is examined, it is observed that the academic achievement score posttest measurements of the students in the experimental and control groups increased compared to the pretest measurement. It is seen that the increase in the experimental group is higher, while the increase in the control group is lower. Judging from the findings obtained from data analysis, it has been concluded that when Web 2.0 tools are used in the science course, it has a positive effect on the academic achievement of students.

Figure 1.

Graphical Representation of The Change in The Pre-Test And Post-Test Academic Achievement Scores



Findings Regarding the Second Research Question

The second question of the study was "Are the academic achievement posttest scores of the students in the experimental and control groups affected by gender?". In order to answer this question, a Two-Way Analysis of Variance was used for Unrelated Samples to question whether the scores differ according to being in the experimental or control group, gender, and the common effect of the two variables. First of all, to determine whether the students' ILMAA posttest scores show normal distribution, their arithmetic means, medians, the closeness of the peaks and skewness, and kurtosis coefficients were examined (Table 10).

Table 10

ILMAA Posttest Mean, Median, Mode, Skewness and Kurtosis Values by Gender

Tests	Group	Gender	Mean	Median	Mode	Skewness	Kurtosis
ILMAA Posttest	Experimental	Girl	16,55	17,00	17,00	-,79	-,20
		Boy	15,29	16,00	18,00	-,45	-,95
	Control	Girl	12,45	13,00	13,00	-,12	-,12
		Boy	11,26	11,00	12,00	,15	-,71

It can be decided whether the data show normal distribution or not when the mean, median, and peak values of each subgroup are close, and the skewness and kurtosis coefficients are small (Can, 2017). When Table 10 is examined, it can be said that the data show a normal distribution because the mean, median, and peak values of the posttest are close, and the skewness and kurtosis values are small. The results of the Levene's Test conducted to determine whether the scores obtained from the posttests show a homogeneous distribution are given in Table 11. As seen in Table 11, when the posttest Levene Test results of the experimental and control groups are interpreted according to gender ($F=1.01$, $p>.05$), it is seen that the data are homogeneously distributed.

Table 11

Posttest Levene Test Results According to The Gender of Experimental and Control Groups

Group	Test	F	df1	df2	sig.
Experimental/Control	Posttest	1,01	3	80	,38

It was decided to use parametric tests as a result of the normal distribution and homogeneous distribution processes performed according to the posttest data of the boys and girls in the experimental and control groups. For this purpose, "Two-Factor Analysis of Variance for Unrelated Samples (2x2 ANOVA)" was conducted for the posttest scores of students in the experimental and control groups.

First, the arithmetic mean and standard deviation values of the academic achievement posttest scores of the students in the experimental and control groups were examined (Table 12).

Table 12

Descriptive Statistics of The ILMAA Posttest Scores by Gender

Experimental/Control	Gender	N	$\bar{X}$	S
Experimental	Girl	17	16,55	2,50
	Boy	28	15,29	2,78
	Total	45	15,80	2,71
Control	Girl	20	12,45	3,97
	Boy	19	11,26	3,75
	Total	39	11,87	3,86
Total	Girl	37	14,39	3,91
	Boy	47	13,63	3,76
	Total	84	13,97	3,82

As seen in Table 12, when the academic achievement posttest scores of female and male students in both experimental and control groups are analyzed, it was found that female students' academic achievement posttest scores ($\bar{X}_{experimental}$=16.55, $\bar{X}_{control}$=12.45), were higher than the academic achievement posttest scores of male students ($\bar{X}_{experimental}$=15.29, $\bar{X}_{control}$=11.26).

Considering this situation in the total of both groups, it is seen that the academic achievement posttest scores of female students ($\bar{X}$=14.39,) are higher than the academic achievement posttest scores ($\bar{X}$=13.63) of male students. Whether the difference between the academic achievement posttest scores of male and female students in each group is significant was analyzed by applying Two-Factor Analysis of Variance for Unrelated Samples (Table 13).

Table 13.

Results of Two-Factor Analysis of Variance for Unrelated Samples for ILMAA Posttest Scores According to Gender

Source of Variance	Sum of squares	df	Mean of squares	F	p	η2
gender	30,64	1	30,64	2,84	,09	-
Group experimental/control)	339,29	1	339,29	31,46	,00	,28
gender*Group	,02	1	,02	,00	,96	,00
Error	862,70	80	10,78			
Total	1215,952	83				

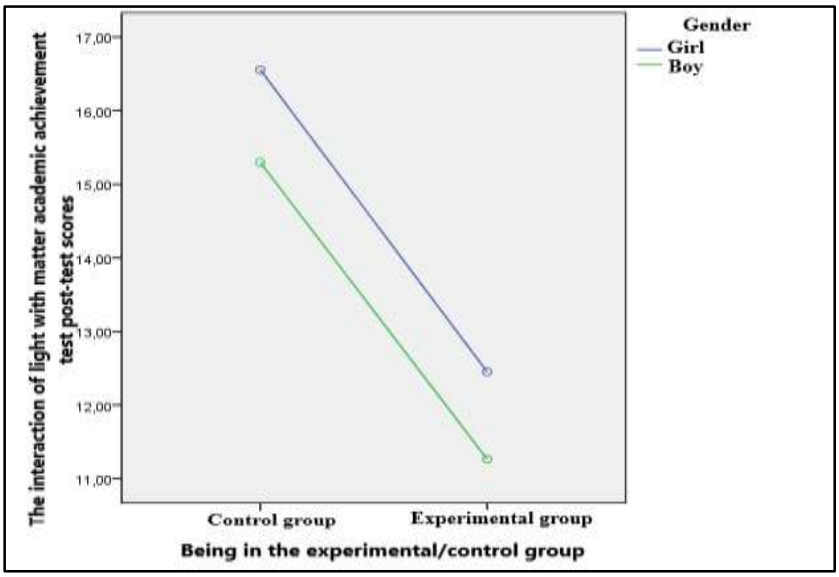
When Table 13 is examined, it can be said that:

1. There is no significant difference between the academic achievement posttest scores ($\overline{X}$=14.39) of the female students and the academic achievement posttest scores ($\overline{X}$=13.63) of the male students (F=2.84, p=.09; p>.05).
2. There is a significant difference between the academic achievement posttest scores of the experimental group students who were taught with Web 2.0 tools and the control group students who were taught according to the existing activities in the curriculum (F=31.46, p=.00; p<.05). The effect of this difference is wide (η^2=,28).
3. The common effect of gender and being in the experimental / control group does not have a significant effect on academic achievement posttest scores (F=.00, p=.96; p>.05). In this case, it can be said that there is no significant difference between the achievements of girls and boys in both the experimental and control groups.

Consequently, the success of the students in the posttest is only affected by their being in the experimental or control group. The graph showing the effect of gender and being in the experimental/control group on the students' ILMAA posttest scores is as follows (Figure 2).

Figure 2

Graphical Representation of The Effect of The Common Effect of Gender and Being in The Experimental/Control Group on ILMAA Posttest Scores



When Figure 3 is examined, it is seen that the academic achievement posttest scores of the female students in the experimental group ($\overline{X}$=16.55) are higher than the academic achievement posttest scores ($\overline{X}$=15.29) of the male students in the experimental group. Similar findings are also valid for control group students. The academic achievement posttest scores ($\overline{X}$=12.45) of the female students in the control group are higher than the academic achievement posttest scores ($\overline{X}$=11.26) of the male students in the control group.

In general, it is seen that the academic achievement posttest scores of the experimental group ($\overline{X}$= 15.80) are higher than the academic achievement posttest score ($\overline{X}$ = 11.87) of the control group. In such graphs, the intersection of the lines indicates the presence of the common effect (Can, 2017). Since the lines on the graph do not intersect in Figure 2, the common effect of gender and being in the experimental/control group has no effect on the academic achievement posttest scores of the students.

Findings Regarding the Third Research Question

The third question of the study is "Do the lesson activities prepared by using Web 2.0 tools have a significant effect on the scores of the students' self-directed learning with technology (SDLT) scale scores?". In the solution of this research question, two-way analysis of variance was used for repeated measurements, since both the measurement results of the experimental and control groups were compared (measurement for unrelated samples) and the experimental or control group was given a pretest followed by a posttest (repeated measurement). First of all, skewness and kurtosis values were examined for four different groups, namely, the pretest and posttests of the experimental and control groups. The results are placed in Table 14.

Table 14

The Skewness and Kurtosis Values of The Experimental and Control Groups for The SDLT Scale

Tests	Groups	Skewness	Standard error	Kurtosis	Standard error
Pretest	Experimental	,10	,35	,00	,69
	Control	-,35	,37	,15	,74
Posttest	Experimental	-,44	,35	-,45	,69
	Control	-,71	,37	,23	,74

If the skewness and kurtosis coefficients are within the limits of -1, +1, it can be interpreted that the scores do not show a significant deviation from the normal distribution (Büyüköztürk, 2018, p.40). For this reason, when Table 3.10 is examined, it is seen that the skewness and kurtosis coefficients of the groups are within the limits of -1, +1, and show a normal distribution. Finally, according to the results obtained from the Levene test, it is stated in Table 15 that there is no difference between variances (p>,05), that is, the condition of equality of variances is met.

Table 15

Homogeneity Test Results Related to The SDLT Scale Pre-Test and Post-Test Scores

Tests	F	df1	df2	sig.
Pretest	,410	1	82	,524
Posttest	1,136	1	82	,290

When the examinations made on the obtained data were evaluated, it was concluded that the necessary assumptions were met to make a two-way analysis of variance for repeated measurements. Self-directed learning with technology scores of students in the experimental and control groups before and after the application, their arithmetic means, and standard deviations were calculated and the results are given in Table 16.

Table 16

Descriptive Statistical Values of The Experimental and Control Groups from The SDLT Scale

Groups	Pretest			Posttest		
	N	$\bar{X}$	sd	N	$\bar{X}$	sd
Experimental	45	3,49	,69	45	3,88	,78
Control	39	3,67	,61	39	3,35	,94
Total	84	3,57	,65	84	3,64	,89

As seen in Table 16, in the experimental group, where lessons were taught with web 2.0 tools, the score of the SDLT scale before the application was increased after the application (from $\overline{X}$=3.49 to $\overline{X}$=3.88) In the control group where the lesson was taught according to the activities in the science lesson curriculum, the pre-test and post-test scores of the SDLT scale are 3.67 and 3.35, respectively. Considering that the highest score to be obtained from this scale is 5, it is observed that there is an increase in the SDLT scores of the students in the experimental groups and a decrease in the scores of the students in the control groups. To determine whether this change is statistically significant or not, a Two-Way Analysis of Variance for Repeated Measures was applied and the analysis results are given in Table 17.

Table 17

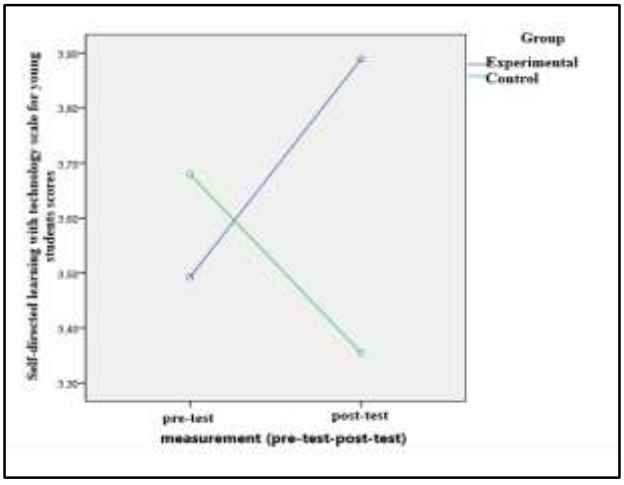
Two-Factor Analysis of Variance Results for Repeated Measures for SDLT Scale

Source of Variance	Sum of Squares	*df*	Mean of Square	F	p	η^2
Group (experimental/control)	1,26	1	1,26	1,91	,17	-
Measurement (pretest-posttest)	,05	1	,05	,10	,74	-
Group * Measurement	5,43	1	5,43	10,56	,00	,11
Error	42,14	82	,514			

When Table 17 is examined, it is seen that as a result of the two-factor analysis of variance for repeated measures to test whether being in the experimental or control group has a significant effect on the scale scores, the group (experimental/control)-measurement (pretest-posttest) common effect, the increase in the score of the experimental group showed that it was significantly higher than the control group (F=10.56, p<.01). In this case, it can be concluded that the use of web 2.0 tools in science lessons has a significant effect on increasing the scores of the SDLT in the unit "Interaction of Light with Matter". It is seen that this situation has a moderate effect (η^2=.11). The graphical representation of the pre-test-post-test differentiation between the experimental group in which the activities performed using Web 2.0 tools and the control group in which the activities in the science curriculum were applied is shown in Figure 3.

Figure 3

Graphical Representation of The Change in The Experimental and Control Group Students' Pretest and Posttest Scores of The SDLT Scale



When Figure 3 is examined, it can be seen that the experimental group students' scores of the SDLT scale increased compared to the pretest measurement of the posttest measurement; and that the control group students' posttest measurement of the SDLT scale decreased compared to the pretest measurement. From the findings obtained from the data analysis, it was concluded that when web 2.0 tools were used in the science course, it had a positive effect on students' self-directed learning with technology.

Findings Regarding the Fourth Research Question

The fourth question of the study was "Are the posttest scores of the SDLT scale of the students in the experimental and control groups affected by gender? In the solution of this research question, the t-Test for Unrelated Samples was used to determine the effect of gender on the posttest scores of the SDLT scale in order to question whether the scores differ according to the common effect of being in the experimental or control group, gender, and these two variables. First of all, to determine whether the posttest scores of the students obtained from the SDLT scale show normal distribution, the closeness of the arithmetic mean, median and peak values, and the skewness and kurtosis coefficients were examined (Table 18).

Table 18

SDLT Posttest Mean, Median, Mode, Skewness, and Kurtosis Values

Test	Group	Gender	Mean	Median	Mode	Skewness	Kurtosis
Posttest	Experimental	Girl	4,04	4,00	4,00	-1,02	3,71
		Boy	3,79	3,75	5,00	-,14	-1,13
	Control	Girl	3,25	3,50	3,50	-1,21	1,59
		Boy	3,46	3,66	3,00	-,61	-,32

Whether the data show normal distribution or not can be decided when the mean, median, and peak values of each subgroup are close, and the skewness and kurtosis coefficients are small (Can, 2017). When Table 18 is examined, it can be said that the data show a normal distribution because the mean, median, and peak values of the posttest are close, and the skewness and kurtosis values are small. The results of the Levene's Test, conducted to determine whether the scores obtained for the posttests show a homogeneous distribution, are given in Table 19.

Table 19

Experimental and Control Groups' SDLT Scale Posttest Levene's Test Results by Gender

Group	Gender	F	df	p
Experimental	Girl Boy	12,43	43	,06
Control	Girl Boy	1,96	37	,17
Total	Girl Boy	3,39	82	,05

As seen in Table 19, when the posttest Levene Test results of the experimental and control groups are interpreted according to gender, the posttest scores of the boys and girls for self-learning with technology in the experimental group ($F=12.43$, $p>.05$), and in the control group ($F=1.96$, $p>.05$) are homogeneously distributed as well as the total scores of male and female students ($F=3.39$, $p>.05$). In this case, judging from the results of normal distribution and homogeneous distribution according

to the posttest data of female and male students in the experimental and control groups, a t-test for unrelated samples was used (Table 20).

Table 20.

T-test Results of The SDLT Scale Posttest Scores for Unrelated Samples According to Gender

Group	Gender	N	$\bar{X}$	S	sd	t	p
Experimental	Girl	17	4,04	,48	43	1,22	,22
	Boy	28	3,79	,91			
	Total	45	3,88	,78			
Control	Girl	20	3,25	,84	37	-,70	,48
	Boy	19	3,46	1,04			
	Total	39	3,35	,94			
Total	Girl	37	3,61	,80	82	-,21	,82
	Boy	47	3,65	,97			
	Total	84	3,64	,89			

As can be seen in Table 20, when the posttest scores of the female and male students in both the experimental and control groups are examined, the female students' SDLT posttest scores were not significantly differed from male students' SDLT posttest scores ($t_{(43)}$=1.22, p>.05; $t_{(37)}$=-.703, p>.05). Considering this situation in the total of both groups, it was seen that female students' posttest scores for the SDLT scale were not significantly different from male students' posttest scores for the SDLT scale ($t_{(82)}$=-,219, p>,05).

Discussion

When the findings of the research are examined, it is seen that there is an increase in the academic achievement scores of students in both the experimental groups and the control groups. As a result of the analysis, the group (experimental/control) measurement (pretest-posttest) joint effect showed that the increase in the score of the experimental group was significantly higher than the control group. In this case, it was concluded that using Web 2.0 tools in science lessons had a significant effect on the increase of the academic achievement scores of the students in the "Interaction of Light with Matter" unit. In the literature, similar studies investigated the effect of using Web 2.0 tools in educational environments on academic success. When the studies in the field of science education are examined, in a study conducted by Koç and Ayık (2017), it was seen that the use of Facebook contributed positively to the academic success of 6th-grade students in science courses. In the research conducted by Gürleroğlu (2019), it was found that the use of web 2.0 applications in accordance with the 5E model in the teaching of the "Force and Energy" unit in the science course increased the academic success of seventh-grade students. In the study conducted by Akgündüz and Akınoğlu (2017), it was concluded that the use of blended learning environments in science lessons increased academic success. In another study conducted by Hursen (2020), it was concluded that the course activities supported by the problem-based learning method prepared with Web 2.0 tools had a significant effect on the academic success levels of prospective teachers. Studies on the use of Web 2.0 tools and their effect on success are also available in courses other than science. In the study conducted by Gündoğdu and Korucu (2018), it was concluded that there was a significant increase in the academic achievement of middle school students studying in the 5th-grade when the lessons were taught with the collaborative lesson activities prepared using various Web 2.0 tools in the Information Technologies and Software course. In a study conducted by Öztürk and Tetik (2015), which investigated the effect of social network-supported activities on the academic achievement of 5th-grade students in the IT course, it was found that the academic success of the students was positively affected. In the studies conducted within the scope of language lessons, there are studies showing that

the use of Web 2.0 tools positively affects academic success. Akçay and Şahin (2012), in a study in which they used the Web Adventure teaching method in Turkish lessons, concluded that it was effective in increasing the academic achievement levels of middle school 6th-grade students. Korkmaz et al. (2019) concluded that the use of the Plickers Web 2.0 application for the assessment and evaluation of English lessons has a positive effect on the academic achievement of 8th-grade students. On the other hand, in a study in which various gamification activities were designed using Web 2.0 tools such as Kahoot and Quizizz in the scientific research methods course, it was observed that the activities gamified with Kahoot increased the academic success of pre-service teachers, but the activities gamified with Quizizz caused a decrease in their academic success (Göksün & Gürsoy, 2019). Another study in which no increase in academic achievement was observed is in the field of Turkish education. In this study conducted by Batıbay (2019), when lessons were taught using Kahoot, one of the Web 2.0 tools, no positive significant increase was observed in the Turkish course academic achievement scores of middle school 7th-grade students. When the studies in the literature with similar characteristics are examined, while most of the studies conclude that the success of students increased when Web 2.0 tools are used both in science and other courses, there is a small number of studies with no significant increase in the academic success of students. The conclusion in this study that Web 2.0 tools increase the academic success of students supports other studies in the literature.

Another result of the study was that the academic achievement posttest scores of female students in both the experimental group and the control group were higher than the academic achievement posttest scores of male students. Whether the difference between the academic achievement posttest scores of male and female students in each group is significant was analyzed by applying Two Factor Analysis of Variance for Unrelated Samples. First of all, the effect of gender was examined, and as a result of the analysis, no significant difference was found between the academic achievement posttest scores of male and female students. Secondly, whether being in the experimental or control group affects academic achievement was investigated and a significant difference in favor of the experimental group was found between the academic achievement posttest scores of the experimental group students who are taught with Web 2.0 tools and the control group students who are taught according to the activities in the existing curriculum. Thirdly whether the common effect of gender and being in the experimental or control group affects academic achievement was investigated, and as a result of the analysis, it was concluded that the common effect of gender and being in the experimental/control group did not have a significant effect on academic achievement posttest scores. In line with the results obtained, it can be said that there is no significant difference between the achievements of boys and girls in both the experimental and control groups, and as a result, it can be said that students' success in the posttest is affected only by being in the experimental/control group. In parallel with this finding of the research, there are similar studies in the literature. In the study conducted by Batıbay (2019), the effect of Kahoot, one of the Web 2.0 tools, on the academic achievement and motivation of middle school 7th-grade students in Turkish lessons was investigated and it was determined that gender did not have a significant effect on the academic achievement scores of the students in the experimental and control groups. In another study conducted by Korucu (2015), no significant effect of gender was observed on the academic achievement test scores of students in the Vocational English course conducted in a technology-supported collaborative environment using web technologies. In the literature, there are few studies investigating the effect of gender in the studies on web 2.0 tools. In most of these studies, it was concluded that gender did not affect the academic success of students. The fact that there is no significant difference in terms of gender between students in the experimental and control groups in this study supports the studies in the literature.

Another result of the study is that there is an increase in the scores of the students in the experimental groups on the SDLT scale and a decrease in the scores of the students in the control groups. As a result of the analysis, it was determined that the group (experimental/control) measurement (pretest-posttest) common effect, the increase in the score of the experimental group was significantly higher than the control group. From the findings obtained as a result of the data

analysis, it was concluded that when the activities in the Unit of Interaction of Light with Matter were designed using Web 2.0 tools, it had a positive effect on students' self-directed learning with technology. There are studies in the literature that parallel these findings. In the study conducted by Karabudak (2019), lesson activities were prepared using animation, simulation, and video within the scope of the Structure and Properties of Matter unit in the 8th-grade, and the effect of this on students' self-learning skills, attitudes towards science and academic achievement was investigated. As a result of the research, it was determined that the computer technologies used positively affect the self-directed learning skills of the students. In another study, Öztürk (2016) found that when lessons were taught using the reverse teaching method in middle school 6th-grade students in teaching programming, students' self-learning scores with technology increased. In the studies conducted within the scope of the mathematics lesson, there are studies showing that the use of Web 2.0 tools positively affects the self-learning levels of students. In a study conducted by Güleç (2019), it was concluded that there is a positive significant difference in the self-directed learning with technology levels of 8th-grade students when the courses are taught using a QR code in middle school mathematics lessons. Similarly, in another study by Erdem (2018), the effect of learning Scratch programming using two different learning and teaching strategies (face-to-face education and technology-assisted learning environments with inverted classroom models) on students' computational thinking skills for 5th-grade students has been investigated. As a result of the research, it was concluded that the students in the classroom where lessons were taught with the reverse-face learning technique contributed positively to their self-directed learning skills. When the studies on web 2.0 tools in the literature are examined, few studies investigated the effect of technology on students' self-learning scores. In a few studies, it has been found that when Web 2.0 tools are used in lessons, there is a positive increase in the self-directed learning scores of students with technology. In this study, as a result of the design of activities in the Unit of Interaction of Light with Matter using Web 2.0 tools, the result that the students increase their self-directed learning scores with technology supports the studies in the literature.

Another result of the study was that there was no significant difference between male and female students in both the experimental and control groups in terms of the posttest scores of the SDLT scale. Similarly, when the sums of the two groups were examined, there was no significant difference between female students' SDLT posttest scores and male students' SDLT posttest scores. In line with these findings, it was concluded that gender did not affect the self-directed learning scores of the students in the experimental and control groups with technology. There are studies in the literature that parallel these findings. In a study by Güneş (2019), the self-directed learning with technology levels of gifted students and the factors affecting them were investigated. As a result of the research, it was observed that the level of self-directed learning with technology did not differ according to the gender of the gifted students. In another study by Taşdemir (2017), it was aimed to evaluate the relationship between gifted students' attitudes towards computers and their self-directed learning with technology. As a result of the research, students' total scores of self-directed learning with technology showed a significant difference in favor of female students. In another study by Demir et al. (2014), the relationship between self-directed learning (SDL) and Computer Attitude was examined in the context of the concept of technology for children using the Structural Equation Model (SEM). Relevant variables were also investigated according to gender, and as a result of the research, it was concluded that the self-directed learning with technology levels of secondary and high school students did not differ significantly according to gender. In the studies of Carson (2012) and Oliveira and Simoes (2006), it was determined that gender does not have a significant effect on students' self-directed learning skills with technology.

There are few studies in the literature investigating the effect of gender on students' levels of self-directed learning with technology. In most of these studies, no effect of gender on students' scores of self-directed learning with technology was found. In a limited number of studies, the effect of gender can be mentioned. In this study, no significant effect of gender on the scores of self-directed learning with technology was found. Since the effect of gender cannot be mentioned in most of the

studies in the literature, it can be said that this study has similar results to other studies in the literature.

In a recent study, pre-service teachers' experiences with Web 2.0 tools were researched and Web 2.0 tools were discussed in personal learning environments. The results of the study concluded that using Web 2.0 has advantages for students in collaborating with other students, accessing learning resources, sharing ideas with others, connecting with more people, and reflecting on their learning experiences. In addition, it was observed that pre-service teachers are prone to using Web 2.0 tools, but they have difficulty in creating personal learning environments using Web 2.0 tools. This emphasizes the importance of teaching personal learning design with Web 2.0 technologies in teacher training (Lim & Newby, 2020).

Conclusion

It is a fact that the developments in Web 2.0 technologies have facilitated information sharing, user-centered activity, and cooperation over the internet. This has led to the effective use of numerous tools and applications such as social networks, blogs, microblogs, wikis, podcasts, vodcasts, Google tools, virtual environments, collaboration tools, mobile applications, video sharing tools in education as well as in many sectors. Thus, it has become possible to bring Web 2.0 applications to the classroom and laboratory as teaching tools. It can be thought that the effective use of web applications that children and young people enjoy in lessons will enable them to focus on the lesson and increase their interest by providing access and strengthening student-teacher communication. In this study, it can be said that the use of Web 2.0 tools in lessons contributed to students' self-directed learning with technology and their experiences had a positive effect on their academic achievement.

Recommendations

When the literature on the use of Web 2.0 tools in lessons is examined, it is observed that there is a limited number of experimental studies on this subject in Turkey. In this direction, it may be suggested to researchers to conduct experimental studies on different subjects in different courses related to Web 2.0 tools.

There are many studies in the literature showing that Web 2.0 tools increase students' collaborative working skills, and researchers can design collaborative learning environments by using Web 2.0 tools in different courses and subjects.

In the literature, there are few studies investigating the effect of using Web 2.0 tools on gender and researchers can conduct different studies investigating the effect of gender.

Many Web 2.0 tools can be used in concept teaching, but there are few studies in the literature on the use of web 2.0 tools in concept teaching. Researchers can study on the use of Web 2.0 tools in teaching concepts with secondary school students in different courses and subjects.

Teachers can introduce students to the Web 2.0 tools to be used before applying the activities they designed to students by using Web 2.0 tools suitable for the outcomes of the curriculum. Once students have learned to use the Web 2.0 tool, they can run the activities. During the implementation phase of the lesson activities prepared using Web 2.0 tools, classes were divided into groups, and studies were carried out. During the studies, some students sometimes remained passive due to the crowd of the groups. In order to avoid such problems, teachers are recommended to take necessary measures in classrooms.

Eba is one of the most important web 2.0 environments used in our country. In this study, it was observed that many active learning methods were designed in the EBA environment, and it attracted the attention of students. Instead of sharing ready-made content in the EBA environment, teachers can design their own learning products and share them with their students.

Internet infrastructure of schools is important in order to carry out course activities using Web 2.0 tools without any problems. After the internet infrastructures of schools are provided, teachers can prepare activities in these classrooms using Web 2.0 tools.

There are some restrictions on the content of Web 2.0 tools and most of the content is offered to users for a fee. The use of these Web 2.0 tools can be facilitated by inter-agency agreements.

Seminars can be organized in schools on the content of Web 2.0 tools and their effective use in teaching environments.

The lack of Turkish language support for most of the Web 2.0 tools limits the use of these tools in the teaching environment. Turkish language support can be provided for these Web 2.0 tools or new Web 2.0 tools can be designed for our country.

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