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The Effects of Web 2. 0 Tools on Seventh-grade Students' Academic Achievement, Visual literacy and Spatial Visualization*

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ABSTRACT
The purpose of this study was to investigate whether the science activities supported by the Web 2.0 tools at the 7th-grade secondary school level had an impact on the students' academic achievement, visual literacy level and spatial visualization skills. The study was designed in accordance with the nonequivalent control group design .The study universe was composed of 180 students from a state school during the 2021-2022 academic year in Turkey. An academic achievement test, Visual literacy scale and Spatial Visualization Test were administered to both groups as pre-tests and post-tests. In the experimental group, science instruction based Web 2.0 tools were used, while science instruction without Web 2.0 tools were used in the control group. This result indicated that the science education based Web 2.0 tools improved the achievement of the students in the topic of cells and divisions. Furthermore, it was furher revealed that the education in which the Web 2.0 tools were used positively affected their visual literacy and spatial visualization. In this respect, the results of this study and the science instructions with Web 2 tools can provide practical help to educators teaching the topic of cells and cell division.

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Introduction

Rapid access to information has become a requirement of modern life. This access is essentially enabled with the use of appropriate technological tools the use of educational technologies in schools renders the lesson fun, accelerates the procurement of outcomes and makes learning more permanent. Technology based teaching and learning processes, tools and equipment will prepare an active learning environment that is more interesting and effective for both teachers and learners. (Ghavifekr & Rosdy, 2015; Katrancı & Uygun, 2013). Furthermore, within the education system, the web-based digital materials essentially are used for many purposes such as doing homework and doing research, preparing lecture presentations, preparing reports, both curricularly and extra-curricularly (Yıldırım & Kaban, 2010). Together with the advancing education technologies, the Web 2.0 tools have come into prominence in the course of adapting them to the education programme so that individuals can access the data they require (Uçak & Şaka, 2022).

The Web 2.0 tools include the use of the internet as an interactive experience in the form of blogs, wikis, forums, etc. and play a more significant role than just accessing information (Perry, 2013). They emancipate the internet from being a platform where ready-made information is consumed and transform it into an educational environment that allows the users to improve and share the content of published information. As the users create and share different types of content, facilitate access to content, and simplify the social interaction between themselves, the Web 2.0 tools are essentially used in many fields as well as in the field of education (Deberlioğlu & Köse, 2010; Perry, 2013). Therefore, they have many contributions to make to the field of education. They can optimize learning, develop students' higher-order thinking and problem-solving skills, and enable students to work collaboratively. Additionally, they create a supportive learning environment, facilitate students' responsibility for their own learning, and promote knowledge transfer to real-life situations (Amevor et al., 2021; Gürleroğlu, 2019; Karaman et al., 2008; Perry, 2013).

The Web 2.0 tools facilitate the data exchange in the learning process, improve the learners' skills significantly, and enable the teachers to become a guide and the students to be in an active position in this process. It is anticipated that the people using the Web 2.0 tools will be able to read the presented visual message and explicate the data in the spatial environment (Dere, 2017). Gilbert (2005) emphasized that a metacognitive sub-skill that supported visualization was defined as spatial visualization. Spatial visualization is defined as the ability to change, rotate, reverse and use the image of an object in the mind (McGee, 1979) to differentiate between three-dimensional objects and two-dimensional representations (Gilbert, 2005), in order to understand their movement imagery and to perform them in the mind (Clement, 1988). There are many studies conducted on this issue in such fields as mathematics, space sciences, music, biology, visual arts, geometry, physics, engineering and architecture (Kaya, 2019). Therefore, the students are expected to describe and understand spatial visual representations, such as graphs, diagrams, and physical models that reflect these concepts and phenomena on many abstract scientific phenomena and concepts (Yang et al., 2023). Thus, visual literacy is a process that encompasses the skills of understanding and expressing visual images (Pilgrim & Bledsoe, 2013). Ausburn and Ausburn (1978) defined *visual literacy* as the skills that enable individuals to understand to use visual messages in order to communicate with others, while Wileman (1993) defined it as the ability to interpret and make sense of visual information and convert the information into visual images. In sum, developing visual literacy skills or spatial ability in science classes becomes an important contributor to the academic success (Barnea & Dori 1999; Gök & Doğan, 2020).

The secondary school science education program reveals that the visual activities and materials play a critical role in the units of "Living Things and Life," "Physical Events," "Matter and Nature," and "World and Universe" (MoNE, 2018). The "Living Things and Life" unit contains topics such as the structure of the cell and cell division that include abstract information. It was reported that "cell" and "cell division" were the abstract concepts being learned or taught in schooling, and they were hard to understand, and concretizing them as visual elements (Fernández et al., 2018; Rahma et al., 2022; Sesli & Kara, 2012; Syawalinda,l et al., 2021). Moreover, it was also reported that some biology teachers were unaware of the ultrastructure of cells and unable to visualize the process of cell division (Öztap et al., 2003; Rahma et al., 2022). Therefore, it is possible to conclude that because of difficulties of the mental visualization of some abstract concepts, science teachers can be supposed to seek alternative teaching approaches in their science instructions.

The results of the previous studies demonstrated that the use of technological course materials in both science education and other courses positively affected students' academic achievement (Arslan & Yıldırım, 2021; Balcı-Çömez et al., 2022; Bilen et al., 2019; Buluş –Kırıkkaya & Yıldırım, 2021; Çetin, 2019; Ergül-Sönmez & Çakır, 2021; Gürleroğlu, 2019; Korkut et al., 2021; Köse et al.; 2003; Özenç et al., 2020; Uysal & Çaycı, 2022), visual literacy (Alpay & Okur, 2021; Alpan Bangir, 2008; Suri Köksal, 2018;), and spatial ability (Benzer, 2018; Çetin, 2020; Ezberci-Çevik et al., 2019; Parmak, 2016; Yıldız & Tüzün, 2011). For instance, Kurnaz and Değermenci (2012) stated that 7th grade students had difficulty in producing scientific mental models in science lessons and suggested that teachers should consider the development of spatial visualization in classroom activities in order to correct this. Dokumacı-Sutcu (2021) on the other hand, indicated that the insufficient level of spatial visualization skills among secondary school students was attributed to the inadequacy in teaching these skills in classroom environments. Barnea and Dori (1999) stated that in a computerized learning environment, three-dimensional structures could be developed using an exploratory approach and that Web 2 tools could change the learning experience for students, including their potential benefits and drawbacks. The present study aimed to understand the effect of science activities supported by the Web 2.0 tools on the students' academic achievement, visual literacy and spatial visualization by using science instruction. Therefore, the result of the study was expected to provide information about the effect of Web 2,0 tools on teaching and learning.The purpose of this study was to investigate whether the science activities supported by the Web 2.0 tools at the 7th-grade secondary school level had an impact over the students' academic achievement, visual literacy level and spatial visualization skills

Research Questions

1. In the teaching of the 7th-grade unit of the Cell and Divisions, is there a significant difference in terms of the academic achievement scores between the experimental group students who were given science instruction with the Web 2.0 tools and the control group?
2. Is there a significant difference in terms of the visual literacy scores between the experimental group students who were given science instruction with the Web 2.0 tools and the control group?
3. Is there a significant difference in terms of the spatial visualization skill scores between the experimental group students who were given science instruction with the theWeb 2.0 tools and the control group?

Methods

Research Design

This study was designed in accordance with the nonequivalent control group design, which is one of a quasi-experimental design. In this design, a comparison group is selected as similar as possible to the experimental group. This design is a non-equivalent group design because the students are not randomly assigned to each class by the researcher. The group serving as the matched group become part of the comparison group (Engel & Schutt, 2014; Cresswell, 2020; Çepni 2021).

Participants

In the experimental group, the sample of the study was composed of a total of 180 seventh grade students (12-13 years of age) of an Imam Hatip (Theology, Divinity & Religious Studies) School in the center of Yıldırım district of the Bursa province in the 2021-2022 academic year. Imam Hatip Schools are the state schools established by the Ministry of National Education. Nevertheless, it has to be noted here that the applied syllabus and textbook of these schools are the same as the other secondary schools. The study sample consisted of a total of 86 male students selected through the convenience sampling method from the school where the first researcher worked as a teacher.There were a total of six classes since the students were homogeneously distributed to the classes by their achievement levels in the school, the achievement levels of all classes were similar to one another. This was the reason why the selection could be made randomly. The first two classes were chosen as the experimental group and the third class as the C group. A total of 60 (30+30) students in two classes constituted the experimental group (E1, E2), and a total of 26 students in one class constituted the control group (C) in the school where the study was implemented.

Data Collection Tools

The Cell and Divisions Unit Achievement Test (CDAT), visual literacy scale and spatial visualization test were used as data collection tools in the study. Difficulty index value (pi), distinctiveness (rix) and KR20 values were calculated for the tests used. If the difficulty index value was close to 1, it meant that the problem was very easy, if it was close to 0, it meant that the problem was very difficult. If the distinctiveness value was higher than .30, it indicated that the problem was sufficiently distinctive value (Ebel & Frisbie, 1991: 228-232). Cronbach's Alpha values were analyzed in order to identify the reliability of the visual literacy scale for this study.

In the study, the CDAT developed by Karslı et al., (2019) was utilized in an attempt to investigate the effect of science instruction based Web 2.0 tools on the students' academic achievement. The test consisted of a total of 36 items. The reliability coefficient of the test was calculated as 0.865. For this study, even though the difficulty level of 4 items (pi=0.20, rix= 0.12), 15 (pi=0.16, rix= 0.24) and 23 (pi=0.24, rix= 0.27).) of the academic achievement test was high, their discrimination was low. The difficulty level of the 7th (pi=0.30, rix= 0.18) item was above the medium level; however, its discrimination was low. The items 4, 7, 15, 23, whose item difficulty and discrimination values would be taken into account, were removed from the test and were not included in the final evaluation. After those questions were removed, the results of the test for which the reliability values were calculated for the study are illustrated in Table 1. The results higher than 0.60, suggested that CDAT test was a reliable measurement tool.

Table 1

CDAT KR-20 Values

Scale	Group	Test	KR-20
CDAT*	E1	Pre-test	.721
		Post-test	.707
	E2	Pre-test	.780
		Post-test	.877
	C	Pre-test	.656
		Post-test	.827

In the study, the 'Spatial Visualization Test' developed by Dokumacı-Sütçü & Oral (2019) was used to investigate the effect of science instruction based Web 2.0 tools on the students' spatial visualization skills. The test aimed to measure a variety of two and three-dimensional spatial visualization skills, such as paper folding, mental dissection, mental integration, cube construction, cube counting, and cube touch count, within the context of seventh-grade level, using different question types within the same test.

Table 2

Spatial Visualization Test Kr-20 Analysis Results

Scale	Group	Test	KR-20
Spatial Visualization*	E1	Pre-test	.800
		Post-test	.888
	E2	Pre-test	.801
		Post-test	.860
	C	Pre-test	.771
		Post-test	.797

The first factor in the test, which had 29 items and a two-factor structure, was referred to as "Two-Dimensional Spatial Visualization" and the second factor was named as "Three-Dimensional Spatial Visualization". For this study, the difficulty index and discrimination value of the spatial visualization test were calculated. As far as the discrimination values were concerned, the items numbered 6 (pi=0.57, rix= 0.25) and numbered 16 (pi=0.77, rix= 0.18) were excluded from the test and were not included in the evaluation. In establishing the reliability of the scale data, the KR-20 analysis was applied for the spatial visualization test for this study. The results are illustrated in Table 2. The results that were higher than 0.60, suggested that the reliability coefficient of the spatial visualization test used in the study was reliable.

In this study, the 'Visual Literacy Scale' prepared by Karaçam (2020) was used in order to investigate the effect of science instruction-based Web 2.0 tools on the level of visual literacy. The scale was 38-item 5-point Likert type and graded as “Always”, “Often”, “Sometimes”, “Rarely”, “Never”.

Table 3

Visual Literacy Scale Cronbach’s Alpha Values

Subscale	Group	Test	Cronbach’s alpha
Using the visual**	E1	Pre- test	.813
		Post- test	.788
	E2	Pre- test	.732
		Post- test	.877
	C	Pre- test	.893
		Post- test	.824
Perceiving the visual **	E1	Pre- test	.775
		Post- test	.854
	E2	Pre- test	.818
		Post- test	.868
	C	Pre- test	.834
		Post- test	.882
Recognizing the visual **	E1	Pre- test	.830
		Post- test	.678
	E2	Pre- test	.618
		Post- test	.630
	C	Pre- test	.682
		Post- test	.662
Thinking about the visual **	E1	Pre-test	.762
		Post-test	.713
	E2	Pre-test	.723
		Post-test	.825
	C	Pre-test	.794
		Post-test	.730
Visual literacy total **	E1	Pre-test	.913
		Post-test	.924
	E2	Pre-test	.909
		Post-test	.949
	C	Pre-test	.938
		Post-test	.941

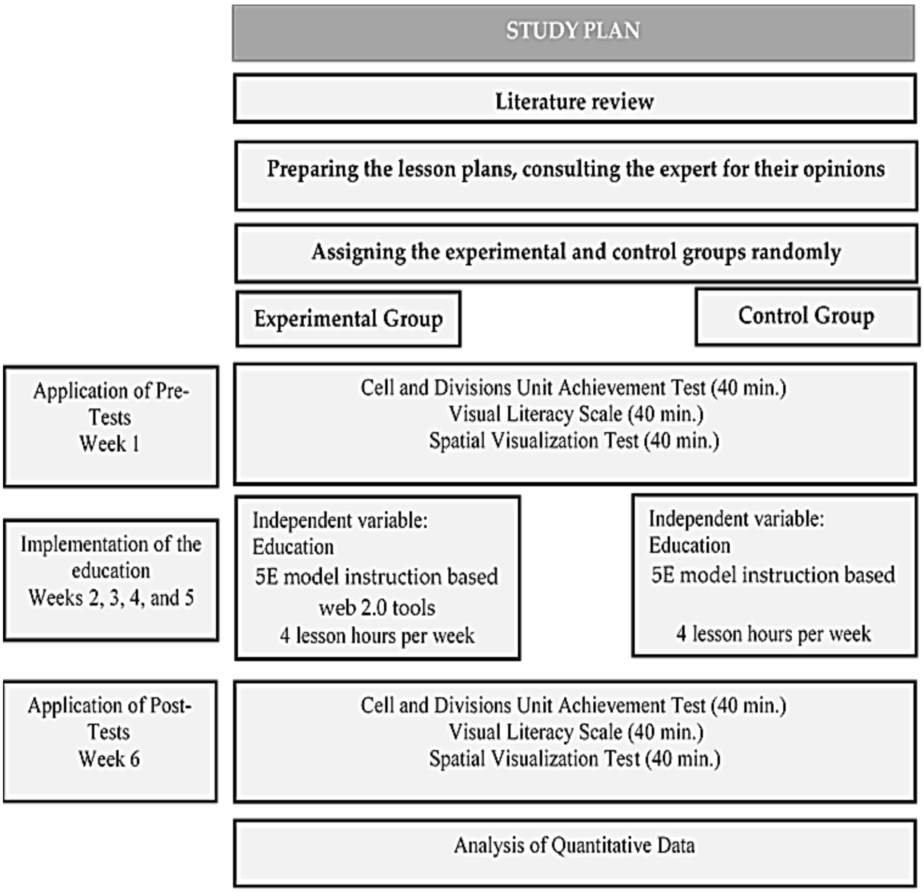
The scale had a four-factor structure consisting of "Using the visual", "Perceiving the visual", "Recognizing the visual" and "Thinking about the visual" sub-dimensions. The “Using the visual” subscale aimed to measure the student's ability to know where to use the visual elements in their lives, to communicate effectively using the visual message, and to create messages with the visual elements. “The Perceiving the visual” subscale aimed to measure awareness, criticism, interpretation, connection and evaluation; the “Recognizing the visual” subscale aimed to measure knowing and understanding what the visual conveyed. Finally, the visual “Thinking about the visual” subscale aimed to measure the ability to think about the visual messages, read visual texts and generate new meanings (Karaçam & Ocak, 2023). The Cronbach's Alpha values for establishing the reliability of the visual literacy scale for this study are presented in Table 3. The results that were higher than 0.60, suggested that the reliability coefficient of the visual literacy test used in the study was reliable.

Data Collection Process

The study was implemented through a 6-week study in the 2021-2022 academic year. The study plan is presented in Figure 1.

Figure 1

Study Plan



Process of Science Instruction

The chapter “Cell and Division” covered in the 7th-grade science curriculum utilized by the science curriculum, (MoNE, 2018) was taught. Both groups utilized the same textbook published and distributed by the Ministry of National Education distributed to the schools (Akdemir & Atasoy, 2021). The science classes were carried out with the aim of getting the students to obtain the acquisitions determined by the science curriculum (MoNE, 2018).The curriculum was suggested as a total 16 lesson hours within four weeks. The planned periods for the "Cell and Divisions" unit target outcomes in this study are presented in Table 4.

Table 4

Cells and Divisions" Unit Outcomes

7.2. CELL AND DIVISIONS
F.7.2.1. Cell Duration: 6 lesson hours Topic / Concepts: Similarities and differences between cells, plants and animal cells, tissues, relationship between the cell-tissue-organ-system-organism, DNA, gene, chromosome F.7.2.1.1. The unit compares the animal and plant cells in terms of their basic parts and functions. F.7.2.1.2. The unit discusses the views on the structure of the cell from past to present by associating them with the technological developments. F.7.2.1.3. The unit explains the relationship between cells, tissues, organs, systems and organisms. Limitations For the basic parts of the cell only the cell membrane, cytoplasm and nucleus are given. Without giving detailed structures of cell organelles, only their names and functions are stated. The relationship between DNA, gene and chromosome concepts are explained.
F.7.2.2. Mitosis Duration: 4 lesson hours Topic / Concepts: Cell division, stages of mitosis, the importance of chromosomes in mitosis, the importance of mitosis for a living organism F.7.2.2.1. The unit explains the relationship between cells, tissues, organs, systems and organisms. F.7.2.2.2. The unit explains that mitosis consists of different successive stages. Limitations The names of the stages of mitosis are not given.
F.7.2.3. Meiosis Duration: 6 lesson hours Topic / Concepts: The formation of reproductive cells by meiosis, the importance of meiosis for living organism, the features that distinguish meiosis from mitosis. F.7.2.3.1. The unit explains the importance of meiosis for living organism. F.7.2.3.2. The unit demonstrates how meiosis takes place in reproductive mother cells on the model. F.7.2.3.3. The unit compares the differences between meiosis and mitosis. Limitations: The stages of meiosis are only given as Meiosis I and Meiosis II. Cell names are not stated during gamete formation. Only sperm and eggs are taught. While the differences between meiosis and mitosis are explained, the differences in the division stages are not taught.

In both groups, a 4-week study was conducted using the Biological Sciences Curriculum Study (BSCS) 5E model instruction model, which has five phases; engagement, exploration, explanation, elaboration and evaluation. Nevertheless, it was observed that there were few studies using the Web 2.0 tools based on the 5E instruction model at the secondary school level (Baki-Çömez, 2021; Özenç et al., 2020) in Turkey. However, this model is known to have an impact on students' outcomes, especially in science education (Bybee et al., 2016; Joswick & Hulings, 2023). Thus, throughout the study, both groups used the 5E model instructions, while the experimental group's instructional activities included Web 2.0-based activities.Those were the Storyboard, Pawtoon, Quiver, Learning App, Canva, Jigsaw Planet Puzzle, World wall, Kahoot and Worldmind and Bubble application. The prepared lesson plans whether to use the 5E format were submitted to the consultation and judgement of three experts, and corrections were made in line with their opinions. The activities carried out in two groups in each week during the implementation process are explained below.

Week1: In the experimental group engagement phase, the cartoon was prepared with the Storyboard. That application was examined, and questions about the cartoon were given to the students.

In the exploration phase, the microscope activity "Let us observe the cell" in the textbook was explained using the Powtoon software. They were asked to implement the activity by being given a microscope to use a ready-made slide and drawing their observation results in their notebooks. The visuals related to plant and animal cells were distributed to the students. The students analyzed the two cells with the augmented reality, - which provided interactive virtual components to the real senses and physical components simultaneously by a video camera in real-time (Sünger & Çankaya, 2019) - application they had previously downloaded onto their smartphones and identified the differences between them. The students without a smartphone worked with those who had one. In the explanation phase, essential explanations were made about the cell and its basic parts based on the augmented reality visuals, and the students took down their notes in their notebooks. In the elaboration phase, the cell images of different living organism were given in the Learning App in order to associate what was learned with real life. They were asked to match which organism these images were relevant to cell pictures. Following that, chromosome and nucleus shape posters prepared with the Canva application. Students asked to establish a relationship between them. In the evaluation phase, a competition was organized on Kahoot. Finally, the students were asked to make jigsaw puzzles of different cells with the Jigsaw Puzzle application.

In the control group engagement phase, the topic was introduced by getting the students to read the case study and asked to answer the questions given in the textbook. In the exploration phase, the students were asked to read the same activity that was carried out in the experimental groups. They just used a microscope and a prepared slide and recorded their observations in their notebooks. In the explanation phase, the visuals of plant and animal cells in the textbook were analyzed, and the differences between them were identified. Based on the visuals in the textbook, explanations were offered about the cell and its basic parts, and the students took down their notes in the notebook. In the elaboration phase, in order to correlate what was learned with real life, the students were asked to match the images of different living organism, whether they had plant or animal cells. Then, explanations were made on the nuclei and chromosome images in the textbook, and the students were able to establish a relationship between the division and the nucleus. The evaluation phase consisted of a multiple-choice test, similar to the questions used in the experimental groups. Finally, the students were completed the missing parts of the plant and animal cell images.

Week2: In the experimental group engagement phase, a cartoon was prepared with the Storyboard application. Then, it was presented to the students, and they were asked to think through the questions from the textbook. In the exploration phase, posters of cell-tissue-organ-system-organism were displayed in the Canva application, and the students were asked to interpret the relationships between these pictures. In the explanation phase, they watched the Education Information Network (EBA) video about the cell- tissue-organ system- organism and then they were given explanation. In the elaboration phase, images of different living organism prepared with the Canva application were shown to the students, emphasizing that not every organism had tissues and systems. In the evaluation phase, a competition was organized on Kahoot. Then, unicellular and multicellular organisms and tissue organ system matching were made with the Wordwall application.

In the control group engagement phase, students were asked the same questions from the textbook as those asked in experimental groups. In the exploration phase, the students were asked to interpret the relationships between the pictures by showing them the cell-tissue-organ-system-organism from the textbook, and then they were given explanation. In the elaboration phase, to students were recognized that not every organism was composed of tissues and systems and, identification cards of different living organisms were shown. In the evaluation phase, matching of unicellular and multicellular organisms and tissue organ system were mached. The instruction was finalized by organizing a competition among the students with multiple choice questions.

Week 3: In experimental group engagement phase, the activity on mitosis entitled "How do yeasts swell?" was implemented. Every phase of the activity was presented with the Powtoon. At the end of the activity, it was associated with the concepts of mitosis . At the end of the activity, the evaluation questions were answered and the activity was associated with the concepts of mitosis. In the exploration phase, the phases of mitosis were drawn on a pre-prepared membrane however, the sequence number was not given. The groups were asked to predict the order in which the phases would occur. They were asked to check their predictions with the augmented reality application they had previously installed on their smart phones. In the explanation phase, explanations about mitosis and its phases were made and students took down notes were taken. In the elaboration phase, the role of mitosis in organ transplantation was explicated. In the evaluation phase, a competition was organized among the students with the activities prepared on the Wordwall. The week was completed by performing a mitosis phase macthing activity which was prepared with the Learning App.

In control group engagement phase the same activity was carried out with the experimental group. However, the phases of the activity were explained in detail. At the end of the activity same activity was carried out with the experimental group as well. In the exploration phase started in a similar to way to the experimental group. Neverthelessthey were asked to check the accuracy of their predictions by analysing the textbook. In the explanation and elaboration phase were conducted similar to experimental groups. In the evaluation phase, matching mitosis stages and stage ranking activities were conducted and the week was finalized by organizing a competition among the students with a multiple-choice evaluation exam.

Week 4: In experimental group introduction stage, a cartoon that was prepared with the Storyboard posed genetics questions from the textbook. The students were asked the questions on that cartoon. In the exploration stage, the unordered meiosis stages prepared with the Learning App were shown to the students and they were asked to order the stages. Then, the students were asked to watch the EBA meiosis video and were expected to check whether their order was correct. The students were asked to explain in which meiosis stages they made mistakes while arranging the order, and the necessary time was granted for them to correct their mistakes. In the explanation phase, to make the concepts relevant to real life, live stage pictures of meiosis were prepared using the Learning App and compared with the drawings in the textbook. The topic was reinforced by making a meiosis model in the reproductive mother cells given on in their textbook. In the elaboration phase, the students were asked to explain the differences between monozygotic twins and dizygotic twins, and how meiosis was affective. They were asked to state their opinions. In the evaluation phase, the students' learning was evaluated with the puzzle prepared with the Wordmint application and a concept map was created with the students through the Bubble application.

In control group introduction stage, questions about genetics within the text in the coursebook were asked. In the exploration stage, the students were shown the unordered meiosis stages drawn on a paper. In the exploration phase, the students were shown the unordered meiosis stages drawn on paper. The students were then asked to check from the textbook whether the order was correct. The following instruction was conducted similar to the experimental group. In the explanation phase, explanations were made on the topic and the drawn images of the meiosis stages were matched with the real images in order to establish a connection with real life The subject was reinforced by making a meiosis model in the reproductive mother cells given in the textbook. In the elaboration stage, the students were shown the stages of meiosis in an unclear order drawn on a piece of paper. In the evaluation stage, what the pupils learned was evaluated with the meiosis puzzle and a concept map.

Data Analysis

In the present study, in which the effect of science instruction-based Web 2.0 tools on students' academic achievement, spatial visualization skills and visual literacy levels was investigated, the SPSS 25.0 package programme was used for the essential statistical analysis on the data collected within the scope of the study. Initially, the 'Normality Test' was conducted to establish whether the data obtained had a normal distribution. As a result of the analyses, it was revealed that the data were consistent with normal distribution and it was accordingly decided to use parametric tests. Subsequently, statistical analyses were performed in order to make comparisons between the E1, E2 and C groups.The dependent t-test (Paired Samples t-test) was utilized in order to compare the pre-test and post-test results of the E1, E2 and C groups within the groups. The effect size (Cohen d) was calculated in an attempt to find out whether the difference between the results of the groups in the study was significant. As a general recommendation, Cohen stated that if the d value was less than 0.2, the effect size could be defined as weak, if it was 0.5 then it was medium, and if it was greater than 0.8, it could be defined as strong. However, it should be noted here that there may be special cases where even a d value of 0.2 can be considered as a strong effect (Kılıç, 2014; Tabachnick & Fidell, 2015). One-way ANOVA (one-way analysis of variance) was performed in order to test whether the difference between the means of the groups was significant. If a significant difference was found between the groups, the multiple comparison test (*post hoc*) was used to find out between which groups this difference or differences existed. The eta squared (η2) coefficient was calculated to estimate the effect size of the relationship between the variables. Cohen reported the eta values as small (η^2 =.01), medium (η^2=.09) and large (η^2=.25) (Tabachnick & Fidell, 2015).

Results

The results obtained by calculating the one-way ANOVA for the independent samples and the eta square coefficient to calculate the effect size of the relationship between the variables, and whether there was a significant difference between the groups in the academic achievement of the students in the Experimental group and C group before and after the instruction are presented in Table 5.

Table 5

One-way ANOVA Analysis Results on the Comparison of the CDAT Scores of the Students in the Experimental Groups and Control Groups between the Groups in the Pre-Test and Post-Test

Test	Groups	N	X	SS	F	p	*Post-hoc* result	η^2
Pre-test	E1	30	10.13	3.67	11.869	.000*	1<3, 2<3	.222
	E2	30	9.03	2.74				
	C	26	13.65	4.50				
Post-test	E1	30	24.97	3.40	6.47	.002	1>2, 1>3	.42
	E2	30	20.10	6.19				
	C	26	21.85	5.51				

*Note.**p<0,00

It was found that the pre-test CDAT score of the students in the C group (x=13.65) was significantly higher than the pre-test CDAT score of the E1 group (x=10.13) and E2 group (x=9, 03) ($p<0.05$). As far as the results of the *post hoc* test are concerned, it was revealed that the CDAT pre-test scores of the C group were higher than the scores of the E1 and E2 groups. Based on the calculated effect size eta-square (η2=.222) result, it was found that this difference was moderately effective. As far as the post-test academic achievement scores are concerned the CDAT score of E1 group (x=24.97) was significantly higher than the CDAT score of C group (x= 21.85) and the CDAT score of E2 group ($p<0.05$). Considering the results of the *post hoc* test, it was found that the academic achievement post-test scores of the E1 group were higher than the scores of the E2 and C groups. As far as the calculated effect size eta-square (η2=,142) result are concerned, it was revealed that this difference was moderately effective. Post-test scores of the E2 group were lower than the other groups. Considering the perspective of the process, Table 5 illustrates that the instruction significantly increased the mean of the E2 group ($p<0.05$).

Table 6 presents the results obtained by calculating the one-way ANOVA for the independent samples and the eta square coefficient to calculate the effect size of the relationship between the variables, and whether there was a significant difference between the groups in the spatial visualization test of the students in the E1, E2 and C groups before and after the instruction. There was no significant difference ($p>0.05$) between the mean scores of the pre-test spatial visualization test results of the students in the E1, E2 and C groups as shown in Table 6. As far as the post-test spatial visualization test scores are concerned, it is clear that there was a significant difference ($p<0.05$) between the mean scores of the students in the E1 and E2 groups and the mean scores of the students in the C group. Based on the *post hoc* test results, it was found that the spatial visualization post-test scores of the E1 and 2 groups were higher than the scores of the C group. Considering the calculated effect size eta-square ($\eta 2=.216$) result, it was revealed that this difference was moderately effective. According to the one-way ANOVA for independent samples, it is possible to say that science instruction based Web 2.0 tools improved the students' spatial visualization skills further.

Table 6

One-way ANOVA Analysis Results Regarding the Comparison of the Spatial Visualization Test Scores of the Students in the Experimental and C Groups between the Groups in the Pre-Test and Post-Test

Test	Groups	N	X	SS	F	P	*Post-hoc* result	η^2
	E1	30	17.17	4.91				
Pre-test	E2	30	16.87	5.06	.312	.733	-	.007
	C	26	17.88	4.73				
	E1	30	21.87	5.20				
Post-test	E2	30	22.07	4.65	11.457	.000*	1>3, 2>3	.216
	C	26	16.38	5.05				

*Note.**p<0,00

The results obtained by calculating the one-way ANOVA for the independent samples and the eta square coefficient to calculate the effect size of the relationship between the variables, and whether there was a significant difference between the groups in the visual literacy of the students in the E1, E2 and C groups before and after the instruction are presented in Table 7.

Table 7

One-way ANOVA Analysis Results on the Comparison of Visual Literacy Scale Scores of the Students in the Experimental and C Groups between the Groups in the Pre-Test and Post-Test

Sub Scale	Test	Groups	N	X	SS	F	p	*Post-hoc* result	η^2
Using the visual	Pre-test	E1	30	3.53	0,64	5.358	.006	2<1<3	.114
		E2	30	3.02	0,59				
		C	26	3.53	0,83				
	Post-test	E1	30	4.01	0,48	7.354	.001	1>2, 1>3	.151
		E2	30	3.48	0,78				
		C	26	3.40	0,70				
Perceiving the visual	Pre-test	E1	30	3.81	0,54	13.614	.000*	2<1<3	.247
		E2	30	3.12	0,61				
		C	26	3.81	0,60				
	Post-test	E1	30	4.23	0,51	8.035	.001	1>2, 1>3	.162
		E2	30	3.65	0,71				
		C	26	3.62	0,75				

group. In this respect, it is possible to say that the use of Web 2.0 tools was more effective in increasing the level of visual literacy compared to the education that was not supported by the Web 2.0 tools. The results in the relevant literature also support this particular finding as well. In the study conducted by Alpay & Okur (2021), it was stated that the materials with digital learning content not only increased the interest and motivation of students, but also improved their level of visual literacy. In another study conducted by Alpan Bangir (2008), it was reported that the visually-rich course materials improved students' visual literacy, but it was emphasized that the education not supported by the Web 2.0 tools did not have enough elements to help the students to improve their visual literacy. In another study conducted by Suri Köksal (2018), it was reported that the use of course materials rich in visual content compared to the education not supported by the Web 2.0 tools in science education improved the students' level of academic achievement as well as their ability to perceive the elements in the visual materials.

It is believed that the practices aimed at increasing the academic achievement levels of the students in science education also significantly improve their cognitive processes. In this framework, the increase in the visual literacy level of the students in the experimental group can be evidence as the other reason for the increase in their academic achievement levels. In a study conducted on secondary school students, it was found that the high level of academic achievement of students positively affected their level of visual literacy as well (Gök, 2019). Visual literacy used to refer to visual reading skills, but over time, it was expanded to include visual comprehension skills (Tüzel, 2010). In the study conducted by Çetinkaya (2019), it was also reported that the practices aimed at improving the level of visual literacy in science teaching increased the students' level of academic achievement and in this sense, there was a significant relationship between their level of academic achievement and visual literacy. In conclusion, it is possible to say that science instruction-based Web 2.0 tools improved students' visual literacy overall.

Conclusion and Implications

The fact that this study was conducted in the regular curriculum adds additional validity to the conclusion that the Web 2 tools, when appropriately integrated into a science topic, can enhance the learning of the abstract concepts of "cell" and "cell division" in the subject of biology or science and thus generatin a positive impact of the Web 2 tools on the students' academic achievement. The potential of the Web 2.0 tools should be exploited in order to maximise the effectiveness of learning the abstract concepts. Furthermore, the study showed that instruction using the Web 2.0 tools positively affected students' visual literacy and spatial visualization. The findings of the study highlighted the effectiveness of Web 2.0 tools. Therefore, the results of Web 2 tools on abstract concepts, visual literacy and spatial visualization may contribute to the widespread use of these tools. Thus, it is possible to conclude that the results of this study has the potential to provide insights into the impact of using the Web 2.0 tools in science education.

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