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The Effectiveness of Teaching with Worksheets Enriched with Concept Cartoons in Science Teaching Laboratory Applications

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The aim of this research is to examine the effects of worksheets enriched with concept cartoons used in the teaching of Science Teaching Laboratory Applications-II course on the academic success and metacognition skill levels of science prospective teachers. The study was carried out using semi-experimental design. The sample of the study, science prospective teachers studying at the 3rd grade at a state university in Turkey, was composed of the experimental group (N = 37) and control group (N = 42), including 79 participants in total. The data were obtained by applying "Academic Achievement Test" and "Metacognitive Activities Inventory". In the analysis of the data, paired sample t-test, independent sample t-test, frequency and percentage calculations were carried out using a suitable statistical program. As a result of the research, although there was an increase in the academic success and metacognition skill level of the prospective teachers who were taught with worksheets enriched with concept cartoons, this increase did not create a statistically significant difference between both groups. This may be due to the fact that science pre-service teachers are not accustomed to the teaching practice and the duration of the research is limited for the development of metacognitive skills. Therefore, the applications of different special education methods and techniques used in science education should be demonstrated in the education faculties within the scope of this course. Thus, it can be ensured that prospective teachers' knowledge about special teaching methods and techniques are not only theoretical but also practical.

Introduction

Although many battles waged in the world history have taken precedence over the reforms to be made in the social, cultural, economic, and educational fields, they have also

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shown societies the importance of science and technology and the need for trained and qualified people. Developments especially after the Second World War have caused an increase in the importance given to scientific education and the science curricula to be updated by accelerating the science and technology race amongst countries (Güneş & Karaşah, 2016; Güven, 2009; Karamustafaoğlu & Yaman, 2006). Turkey has also been affected by these developments in the world of science education. The initiation of the project of Science High School by the Ministry of National Education in cooperation with the Ford Foundation, the establishment of the Scientific Commission for Improving the Science Teaching and the realization of the projects of Scientist Training Group Educations (STG-E-7, STG-E-14 and STG-E-23) by this commission in cooperation with the Scientific and Technological Research Council of Turkey and the Ford Foundation are among the activities carried out to improve the science teaching (Turgut, 1990; Ünal, Coştu, & Karataş, 2004). When the content of all the projects related to the science teaching was examined, the common point that stood out was observed to be the need for student-centered teaching and laboratory studies in scientific education (Ayas, 1995; Hofstein & Lunetta, 2004; Karamustafaoğlu & Yaman, 2006; Karplus, 1977; McInerney, 1987; Sülün & Balkı, 2008; Turgut, 1990; Ünal, Coştu, & Karataş, 2004). Moreover, in most of the current studies, it is stated that the student-centered laboratory approach provides more positive outcomes than the traditional laboratory approach (Aktaş & Doğan, 2018; Demircioğlu, 2011; Gårdebjer, Larsson, & Adawi, 2017; Marchut & Gormally, 2019; Şimşir, Ünal, & Yerlikaya, 2018; Ural, 2016).

Most of the studies on laboratory practices in the field of scientific education indicate that laboratory practices cannot be accomplished fully in the science teaching due to both environmental factors (lack of physical means, materials etc.) and teacher-related factors (Çil, Kar, İri, Şahin Akyüz, & Yanmaz, 2014; Güneş, Şener, Topal Germi, & Can, 2013; Lowe, Newcombe, & Stumpers, 2013; Uluçınar, Cansaran, & Karaca, 2004). Elimination of the deficiencies of science teachers, who are responsible for raising the future generations in this field, and training prospective teachers are as important as the improvement of science and technology to create a contemporary society. In the relevant literature, several studies show the insufficiency of the trainings and in-service courses related to experiments and laboratory method practices given to teachers, who are the managers of the teaching process, as the most significant cause of this situation (Aydoğdu, 1999; Kocakulah & Savaş, 2011; Uluçınar, Cansaran, & Karaca, 2004). Thus, it is necessary to train science teachers and prospective teachers in an equipped way in terms of experiments and laboratory method practices.

In the 1997-1998 academic year, when a transition into eight-year compulsory primary education was executed, the teacher training programs of the faculties of education were restructured, and the focus was placed on applied courses (Council of Higher Education [CoHE], 2007). However, the fact that no detailed information was given regarding how to implement applied courses brought about different practices in the laboratory practices course in the faculties of education. Later, this brought up training teachers in line with the requirements of the age and the problems encountered during the implementation of the teacher training programs as a topic of discussion. In order to overcome these problems, the teacher training programs were updated in 2007 and 2018 with the changes made in the science education program in 2005, 2013 and 2018 in primary education program.

When the 2007 science teacher training program is reviewed, it grabs attention that the name of the laboratory courses given at the 3rd grade was changed into Science Teaching Laboratory Applications I-II, and the aims of the course were expressed more clearly and expanded (CoHE, 2007). In 2018, no change was made in the name and objectives of the

course, but the theoretical course hours were reduced, and the applied hours were not changed (CoHE, 2018). This situation shows that the practice part gains more weight during the weekly course hours. Within the scope of this course, it is seen that the behaviours expected from prospective teachers consist of implementing technology- supported laboratory practices, preparing experimental worksheets and reports, designing experiments from closed ended to open ended structures with simple materials by making use of the science and technology program and presenting these experiments (CoHE, 2018). Hence, in this study, worksheets enriched with concept cartoons were used in the course of Science Teaching Laboratory Applications-II in order to enable 3rd-grade prospective science teachers to see the practices of the active learning methods and techniques they knew theoretically. Worksheets are the teaching materials containing all the stages of the course enabling the active participation of the students in the course by making it easy for the whole class to follow the lesson (Yiğit & Akdeniz, 2000). In the literature, worksheets are seen to be named in different forms, such as study papers and exercise sheets (Özmen & Yıldırım, 2005). Applying written and oral exams to prepare students for the experiment and conducting studies by reporting the results after the experiment are not so effective in learning (Bilen, 2009). On the other hand, the worksheets that are applied differently from the classic laboratory approach enable the active participation of the students help with the improvement of the experimental process skills (preparing the experimental setup, taking measurements etc.) which are among the scientific process skills (Kurt, 2002). Therefore, the use of worksheets was preferred in this study, which was conducted in the Science Teaching Laboratory Applications-II course.

It is necessary to plan the worksheets well so that the expected behavioural changes can be observed in students (Kurt, 2002; Saka, 2001). In this study, a worksheet was developed for each subject, and 15 worksheets were used in total. In the first section of the worksheet, there are open ended questions and concept cartoons related to the subject. In the later section, the aim of the experiment, necessary experiment materials, implementation, and the part where the data will be recorded are stated. In the last section, there is summarized information about the subject and open-ended evaluation questions with respect to the improvement of metacognitive skills. By using particularly concept cartoons in the first section of the worksheets developed, it is aimed to attract the attention of the pre-service teachers to the subject, improve their ability of prediction and enable their active participation in the course.

Thus, Durmaz (2007) expresses that concept cartoons can be used in the introductory stage of the course to examine the preliminary knowledge of the students, attract their attention, create an environment for discussion, and reveal their misconceptions by obtaining their opinions about the subject. Moreover, supporting the verbal elements in concept cartoons with images and concretization of the abstract scientific concepts help with meaningful learning (Kirişcioğlu & Başdaş, 2007, as cited in Şaşmaz Ören, 2009, p. 998). Concept cartoons are the cartoons in which 3 or 4 cartoon characters discuss their opinions without any intention of humour in line with scientific causes regarding a scientific concept in a situation we might encounter in daily life. They were developed as a learning-teaching technique by Brenda Keogh and Stuart Naylor (Keogh & Naylor, 1999). In the relevant literature, concept cartoons are usually used in the Science and Physics teaching for secondary school students, however, it can be said that the number of the studies on prospective teachers studying in the same fields is limited (Naylor & Keogh, 1999; Uğurel & Moralı, 2006). In this sense, it can be said that concept cartoons constitute a learning and teaching method which can address different age groups (Durmaz, 2007). Thus, this research is thought to make contribution to the relevant literature since it is about the teaching of the prospective teachers. In the literature



review, it was seen that most of the relevant studies were related to the effects of concept cartoons on concept teaching and positively affected conceptual understanding (Bakır, 2019; Karakırık, 2019; Külekci, 2019; Minářechová, 2016; Şendur, Sapa, Gürer, & Ataseven, 2017; Taşlıdere, 2013). In addition, in the related literature, concept cartoons are indicated as an effective technique that is frequently used by many researchers to determine misconceptions (Chin & Teou, 2010; Kaplan, 2017). However, in the study conducted by Yorgancı and Erduran Avcı (2017) to reveal the misconceptions of 7th grade students about mass and weight using different techniques, it was also determined that open-ended questions were more effective than concept cartoons in determining their misconceptions. On the other hand, it has been observed that a significant part of the studies in the relevant literature are related to the effects of concept cartoons on cognitive and affective characteristics such as academic achievement (Ceylan, 2015; Kara, 2017; Sinanoğlu, 2017; Yüca, 2019), attitude (Kocakavak, 2019; Pınarkaya, 2017; Şenocak, 2018) and motivation (Ayhan, 2017; Meriç, 2014; Yılmaz Korkut & Şaşmaz Ören, 2018). It was seen that the number of the studies related to concept cartoons with samples consisting of teachers (Balım, Ormancı, Evrekli, Kaçar, & Türkoğuz, 2016; Duban, 2013) or prospective teachers (Gökmen, 2020; İzgi, 2012; Köklükaya, Güven Yıldırım, & Selvi, 2016; Taşlıdere, 2014) were low. Besides, no studies where worksheets enriched with concept cartoons were used in the science teaching laboratory applications for prospective teachers were encountered. Hence, it is believed that this study will be an example for both teachers and prospective teachers in terms of seeing how the concept cartoons were implemented in laboratory practices.

In the 2018 Science Curricula for Secondary School, an inquiry-based teaching strategy is adopted, and it is stated that teachers should only play a role in guiding students for preparing experiments, exploring information, creating argumentation and making an explanation (Ministry of National Education, [MoNE], 2018). Accordingly, it can be mentioned that teachers are expected to guide individuals in their training, who can plan their own learning process. In this sense, metacognitive skills, which are defined as the strategy of planning the learning, managing the comprehension or interpretation of information and individuals' self-evaluation, should be developed both in teachers and prospective teachers (Açıkgöz, 2000, as cited in Tüysüz, Karakuyu, & Bilgin, 2008, p. 148). According to Yıldız and Ergin (2007), if students are aware of what their preliminary knowledge about the subject is and how it will affect the subject they will learn and if they can plan what to do to eliminate their deficiencies, it means they can use the metacognitive strategies. In the relevant literature, there are studies showing that concept cartoons are effective in determining and eliminating misconceptions and increasing academic achievement (Demir, Uzoğlu, & Büyükkasap, 2012; Karakırık, 2019; Karakuş, 2019; Şenocak, 2018). Additionally, as an environment appears for discussion in the implementation of concept cartoons, their abilities of questioning can also be said to improve their levels of argumentation (Balım, İnel Ekici, & Özcan, 2016; Karabiber, 2019; Özçelik, 2019; Yüca, 2019). For this reason, it is remarkable that the number of studies investigating the effects of concept cartoons on some cognitive skills (inquiry, scientific process skills and others.) has increased in recent years (Balım, İnel Ekici, & Özcan, 2016; Cin, 2013; Özçelik, 2019; Özyalçın Oskay & Efil, 2016). However, in the literature review, no studies on the effect of concept cartoons on metacognitive skills have been encountered. Due to aforementioned reasons, it was assumed necessary to conduct this study, and it was aimed to research the effect of the worksheets enriched with concept cartoons used in the course of Science Teaching Laboratory Applications-II on academic achievement and metacognitive skill levels of the prospective teachers.

Problem Statement and Sub-problems

Does the implementation of the course of Science Teaching Laboratory Applications-II via the worksheets enriched with concept cartoons have an effect on the academic success and metacognitive skills of the prospective teachers?

- (1) Is there a statistically significant difference between the academic achievement pre-test scores of the experimental and control group prospective teachers?
- (2) Is there a statistically significant difference between the academic achievement post-test scores of the experimental and control group prospective teachers?
- (3) Is there a statistically significant difference between the metacognition pre-test scores of the experimental and control group prospective teachers?
- (4) Is there a statistically significant difference between the metacognition post-test scores of the experimental and control group prospective teachers?
- (5) Is there a statistically significant difference between the metacognition pre-test and post-test scores of the experimental group prospective teachers?
- (6) Is there a statistically significant difference between the metacognition pre-test and post-test scores of the control group prospective teachers?

Method

Research Model

In this study, quasi-experimental design, one of the quantitative research methods, was used. Experimental research method is a research method that allows researchers to manipulate the desired experimental variables, to control other variables as much as possible, and to establish a cause-effect relationship between the measurements and the variables when research cannot be conducted in natural environments (Köklü & Büyüköztürk, 2000). However, in experimental studies, researchers should pay attention to the random assignment of the participants in order to ensure the equivalence of the initial situation of the groups. In some cases, random distribution of individuals to groups may not be possible when random assignment is made. Especially in educational research, such situations are frequently encountered. In order to overcome such a situation, a semi-experimental method is used, in which one of the existing groups is determined as random experimental group and the other as control group. The research was carried out on the biology subjects of the Science Teaching Laboratory Applications-II course in the spring term of the 2014-2015 academic years.

Table 1. Symbolic Representation of the Experimental Method Applied in the Research

Groups	Pre-tests	Teaching Processes	Post-tests
Experimental Group	T ₁ and T ₂	Teaching with worksheets enriched with concept cartoons	T ₁ and T ₂
Control Group	T ₁ and T ₂	Existing teaching used in science teaching laboratory applications course teaching	T ₁ and T ₂

In Table 1, while T₁ shows the Academic Achievement Test, T₂ shows the Metacognitive Activities Inventory. After the pre-tests (T₁ and T₂) were applied to the groups, the process was carried out in accordance with the planned instruction. At the end of the procedure, post-tests (T₁ and T₂) were repeated and the cause-and-effect relationship between the variables was determined.

Study Group

The population of research, studying at a state university in Turkey, consists of 3rd grade science prospective teachers, who are assigned to randomly selected experiment (N = 37) and control (N = 42) groups. Some information about the groups in the research is given in Table 2.

Table 2. Some Information about the Groups in the Research

Gender (f)	Experimental Group		Control Group	
	Female	Male	Female	Male
	29	8	34	8

As seen in Table 2, there are 29 females, 8 males in the experimental group and 34 females and 8 males in the control group.

Data Collection Tools

The data in the study were obtained from "Academic Achievement Test" and "Metacognitive Activity Inventory".

Academic Achievement Test

This test was generated by researchers to detect the academic achievements of science prospective teachers for biology subjects of Science Teaching Laboratory Applications-II course for purpose of the study. While preparing the test, the subjects were determined by examining 2013 Secondary School Science Course Curriculum and the content of science education undergraduate program curriculum of Council of Higher Education together with two associate professors teaching Science Teaching Laboratory Applications-II. The identified subjects are presented in Table 3.

Table 3. Subjects Determined Within the Content of Science Teaching Laboratory Applications-II Course

Weeks	Subjects
First	Sense organs
Second	Acid rains, Greenhouse Effect, DNA, Urinary System
Third	Photosynthesis, Blood Group Determination, Blood Pressure
Fourth	Substance Transfer Through Cell Membrane, Cellular Respiration, Germination

Learning outcomes for the determined subjects were developed by the researcher as they are not in the science education undergraduate program course content of Council of Higher Education in Turkey. In the development of the test, biology questions related to the achievements determined in various national exam preparation books were used. The questions were chosen assuring that there was at least one question from each level according to Bloom's taxonomy, but mostly by taking into account high-level cognitive skills. The test is multiple choice and the questions have five options. For the reliability study, the developed academic achievement test was applied to 4th grade science prospective teachers (N=140). The content and appearance validity of the test were obtained by taking expert opinion and KR-20 reliability coefficient was determined as 0.84.

Metacognitive Activities Inventory

"Metacognitive Activities Inventory" created by Cooper, Urena and Stevens (2008) and translated into Turkish by Tüysüz, Karakuyu and Bilgin (2008) was utilized to determine

the metacognition skill levels of prospective science teachers. This scale is a five-point Likert-type scale with 27 items in total. The first 19 items in the scale are positive and the other 8 items are negative. When the scale is scored, the lowest score that can be obtained is 27 and the highest score is 135. Cronbach α - internal consistency reliability coefficient was calculated as 0,778.

Teaching Processes

Before starting the teaching, "Academic Achievement Test" and "Metacognitive Activities Inventory" pre-test were applied to both classes determined as random experimental and control groups. Later, since the content of Science Teaching Laboratory Applications-II course consisted of physics, chemistry, and biology courses, both groups were divided into 3 groups and received training for 4 weeks from these courses. The teaching process lasted a total of 12 weeks.

Experimental Group

During the teaching process, worksheets enriched with 15 concept cartoons generated by the researcher were utilized. Since the concept cartoons developed were for biology, this study was carried out in a biology lesson.

Control Group

Science Teaching Laboratory Applications I and II courses are carried out according to the current science teacher training program. According to this training program, all prospective science teachers made 30-minute presentations in accordance with the 5E teaching model for 5th and 6th grade biology subjects previously determined in the Fall semester Science Teaching Laboratory Applications-I course. This teaching process was adopted as the teaching process of the control group, not interfering with this current teaching. Since this study was carried out within the scope of the Science Teaching Laboratory Applications-II course, the prospective science teachers in the control group made 30-minute presentations in accordance with the 5E teaching model on the previously determined 7th and 8th grade biology subjects. While prospective teachers mostly performed student-centered activities (experiments, concept maps, etc.) in their presentations, they used teacher-centered techniques (question-answer, explanation, etc.) in the explanation phase of the 5E model. In addition, concept cartoons were not used in any of these presentations made by the control group prospective teachers in accordance with the 5E teaching model.

Data Analysis

The quantitative data collected in the study, were analyzed with the help of a suitable computer program using descriptive and inferential statistics techniques. Kolmogorov-Smirnov test, which is one of the normal distributions analyses, was made to decide which tests should be done in the analysis of the data obtained from the research. The outcomes of the Kolmogorov-Smirnov test are presented in Table 4.

Table 4. Academic Achievement and Metacognition Pre-Test and Post-Test Kolmogorov-Smirnov Test Outcomes

Groups	Tests	Statistic	sd	Skewness	p
Experimental and Control Groups	Academic Achievement Pre-test	0,097	79	-0,236	0,063
	Academic Achievement Post-test	0,100	79	-0,227	0,048*
	Metacognition Pre-test	0,079	79	-0,496	0,200
	Metacognition Post-test	0,086	79	-1,016	0,200

*When $p < 0.05$, the difference is significant.

According to the analysis of the Kolmogorov-Smirnov test in Table 4, since the normal distribution significance level of the data were $p > 0,05$, it was detected that the scores showed a normal distribution. Only the significance level of academic achievement post-test scores was found to be $p < 0,05$. However, academic achievement can be accepted as a normal distribution since the skewness coefficient of the post-test scores is between -1 and +1 (Büyüköztürk, 2013). Therefore, all data obtained from the study show normal distribution. Therefore, to compare the groups statistically, paired from parametric tests and independent sample t-test analyses were performed. 0,05 was accepted as the level of significance in the interpretation of the results.

Findings

In this part, the findings obtained from the statistical analysis on the effect of Science Teaching Laboratory Applications-II course, which was carried out with worksheets enriched with concept cartoons, on the academic achievement and metacognition skill levels of 3rd grade science prospective teachers were presented in line with the determined sub-problems.

Findings Associated with the First Sub-Problem

In the first sub-problem of the research, it is aimed to determine whether there is a statistically significant difference between the academic achievement pre-test scores of the prospective teachers in both groups. For this purpose, the correct answer percentages in the academic achievement pre-test of both groups are presented in Table 5.

Table 5. Correct Answer Rates of the Both Groups in Academic Achievement Pre-test Application

Item Number	Experimental Group				Control Group			
	True (f)	(%)	False (f)	(%)	True (f)	(%)	False (f)	(%)
1	30	81,1	7	18,9	29	69	13	31
2	23	62,2	14	37,8	24	57,1	18	42,9
3	30	81,1	7	18,9	35	83,3	7	16,7
4	19	51,4	18	48,6	14	33,3	28	66,7
5	37	100	0	0	37	88,1	5	11,9
6	26	70,3	11	29,7	30	71,4	12	28,6
7	14	37,8	23	62,2	23	54,8	19	45,2
8	12	32,4	25	67,6	7	16,7	35	83,3
9	22	59,5	15	40,5	28	66,7	14	33,3
10	24	64,9	13	35,1	30	71,4	12	28,6
11	25	67,6	12	32,4	21	50	21	50
12	28	75,7	9	24,3	36	85,7	6	14,3
13	17	45,9	20	54,1	6	14,3	36	85,7
14	7	18,9	30	81,1	6	14,3	36	85,7
15	30	81,1	7	18,9	37	88,1	5	11,9

16	13	35,1	24	64,9	28	66,7	14	33,3
17	25	67,6	12	32,4	23	54,8	19	45,2
18	25	67,6	12	32,4	31	73,8	11	26,2
19	7	18,9	30	81,1	9	21,4	33	78,6
20	12	32,4	25	67,6	13	31	29	69
21	7	18,9	30	81,1	15	35,7	27	64,3
22	27	73	10	27	34	81	8	19
23	15	40,5	22	59,5	25	59,5	17	40,5
24	25	67,6	12	32,4	31	73,8	11	26,2
25	18	48,6	19	51,4	18	42,9	24	57,1
26	13	35,1	24	64,9	14	33,3	28	66,7

As seen in Table 5, 14th, 19th and 21st items were answered with least percentage correctly by the prospective teachers in the experimental group. These questions are related to respectively substance transport through cell membrane, cellular respiration, and nasal from the sensory organs. In the control group prospective teachers, it was determined that the 13th and 14th items related to the photosynthesis and the transfer of substances through the cell membrane were answered at least correctly. When the situation of these questions between groups was examined, % 18,9 of the experimental group prospective teachers answered 14th, 19th and 21st items correctly, while %14,3 of control group prospective teachers answered 13th and 14th items correctly. When the most correctly answered questions in both groups were examined, it is seen that 5th item related to acid rains was answered correctly by %100 of experimental group prospective teachers, the 5th and the 15th items related to the acid rains and the sensory organs (eye) were answered correctly by %88,1 of the control group. In the academic achievement pre-test application, the correct answer mean of the experimental group is %55,2, while the correct answer mean of the control group is %55,3. Before the application, independent sample t-test was utilized to compare the academic achievement of the groups. The findings obtained were presented in Table 6.

Table 6. Independent Sample T-Test Outcomes Regarding Academic Achievement Pre-test Scores of Groups.

Group	N	\bar{X}	S	sd	t	p
Experimental	37	14,35	2,61	77	0,047	0,962
Control	42	14,38	2,93			

*The difference is important when $p < 0,05$.

When Table 6 is analyzed, it is seen that there is no significant difference between the academic achievement pre-test scores of the prospective teachers in the groups ($t_{77} = 0,047$, $p > 0,05$). According to the score averages and independent sample t-test findings, it can be said that the academic achievement of the groups is close to each other before the application.

Findings Associated with the Second Sub-Problem

In the second sub-problem in the research, it was aimed to examine whether the difference between the academic achievement post-test scores of the prospective teachers in the groups was statistically significant. For this purpose, the correct answer percentages regarding the academic achievement of both groups in the post-test application are presented in Table 7.

Table 7. Correct Answer Rates of the Both Groups in Academic Achievement Post-test Application

Item Number	Experimental Group				Control Group			
	True		False		True		False	
	(f)	(%)	(f)	(%)	(f)	(%)	(f)	(%)
1	36	97,3	1	2,7	32	76,2	10	23,8
2	24	64,9	13	35,1	34	81	8	19
3	33	89,2	4	10,8	39	92,9	3	7,1
4	17	45,9	20	54,1	23	54,8	19	45,2
5	37	100	0	0	40	95,2	2	4,8
6	27	73	10	27,0	32	76,2	10	23,8
7	23	62,2	14	37,8	27	64,3	15	35,7
8	10	27	27	73	9	21,4	33	78,6
9	24	64,9	13	35,1	30	71,4	12	28,6
10	26	70,3	11	29,7	32	76,2	10	23,8
11	26	70,3	11	29,7	24	57,1	18	42,9
12	30	81,1	7	18,9	40	95,2	2	4,8
13	16	43,2	21	56,8	18	42,9	24	57,1
14	14	37,8	23	62,2	18	42,9	24	57,1
15	33	89,2	4	10,8	40	95,2	2	4,8
16	27	73	10	27	28	66,7	14	33,3
17	30	81,1	7	18,9	25	59,5	17	40,5
18	29	78,4	8	21,6	35	83,3	7	16,7
19	15	40,5	22	59,5	15	35,7	27	64,3
20	17	45,9	20	54,1	16	38,1	26	61,9
21	12	32,4	25	67,6	16	38,1	26	61,9
22	29	78,4	8	21,6	32	76,2	10	23,8
23	22	59,5	15	40,5	22	52,4	20	47,6
24	26	70,3	11	29,7	25	59,5	17	40,5
25	15	40,5	22	59,5	23	54,8	19	45,2
26	16	43,2	21	56,8	20	47,6	22	52,4

According to the data in Table 7, it can be said that the 8th item related to subject of the excretion was answered least by the prospective teachers in both groups. %27 of the experimental group and % 21,4 of the control group answered this item correctly.

When the most answered questions are examined, it is seen that %100 of the experimental group answered 5th item related to acid rains correctly, while the control group responds correctly to the 5th, 12th and 15th items related to acid rains, blood pressure and sensory organs (eye) at the rate of 95.2%. In the academic achievement post-test application, which was carried out after teaching with worksheets enriched with concept cartoons, the correct answer mean of the experimental group was 63.8%, while the correct answer mean of the control group was 63.6%.

After the application, independent sample t-test was utilized to compare the academic success of the groups. The findings obtained were presented in Table 8.

Table 8. Independent Sample T-Test Outcomes Regarding Academic Achievement Post-test Scores of Groups.

Group	N	\bar{X}	S	sd	t	p
Experimental	37	16,59	3,51			
Control	42	16,55	2,97	77	0,064	0,949

* The difference is important when $p < 0,05$.

When the Table 8 are examined, it can be said that there is no significant difference between

the experimental and control group prospective teachers' academic post-test scores ($t_{77}=0,064$, $p>0,05$). According to the score averages and independent sample t test findings, it can be said that the academic success of the groups is close to each other after the application. However, when the mean of the pre-test and post-test correct answer percentages of both groups are compared separately, the pre-test correct answer mean (%55,2) of the experimental group is lower than the pre-test correct answer mean (%55,3) of the control group. On the other hand, in the post-test correct answer mean of the groups, it was determined that the experimental group (63,8%) had a higher mean than the control group (63,6%). According to these findings, at the end of the education, the academic success of the groups is close to each other and academic success has increased in both groups. In addition, the experimental group, whose academic achievement was lower, compared to the other group before the application, and the academic achievement increased more than the control group after the application.

Findings Associated with the Third Sub-Problem

In the third sub-problem, it was aimed to detect whether the difference between the metacognition pre-test scores of the prospective teachers in the groups was statistically significant. Independent sample t-test was utilized to compare the metacognition pre-test scores of both groups. The outcomes obtained are shown in Table 9.

Table 9. Independent Sample T-Test Outcomes Regarding Metacognition Pre-test Scores of Groups.

Group	N	\bar{X}	S	sd	t	p
Experimental	37	98,30	15,74	65,776	1,612	0,112
Control	42	103,38	11,67			

*The difference is important when $p < 0,05$.

When the outcomes in Table 9 are analyzed, it is seen that there is no significant difference between the metacognition pre-test scores of the prospective teachers in the groups ($t_{65,776}=1,612$, $p>0,05$). When the mean scores and significance value of both groups in Table 9 are evaluated together, it is seen that the groups are close to each other in terms of metacognition skill level before application.

Findings Associated with the Fourth Sub-Problem

In the fourth sub-problem, it was aimed to detect whether the difference between the metacognition post-test scores of the prospective teachers in the groups was statistically significant. Independent sample t-test was used to compare the metacognition post-test scores of the groups. The outcomes obtained are shown in Table 10.

Table 10. Independent Sample T-Test Outcomes Regarding Metacognition Post-test Scores of Groups.

Group	N	\bar{X}	S	sd	t	p
Experimental	37	101,86	16,00	77	0,537	0,593
Control	42	103,50	10,85			

*The difference is important when $p < 0,05$

When Table 10 is examined, it is seen that there is no significant difference between the metacognition post-test scores of the prospective teachers in the groups ($t_{77}=0,537$, $p>0,05$). When the mean scores and significance value of both groups in Table 10 are evaluated together, it is seen that the groups are close to each other in terms of metacognition skill level after application.



Findings Associated with the Fifth Sub-Problem

In the fifth sub-problem, it was aimed to examine whether the difference between the metacognition pre-test and post-test scores of the experimental group prospective teachers was statistically significant. The outcomes obtained by using paired sample t-test are given in Table 11.

Table 11. Paired Sample t-Test Outcomes Regarding the Comparison of Metacognition Pre-test and Post-test Scores of Experimental Group

Tests	N	\bar{X}	S	sd	t	p
Pre-test	37	98,30	15,74	36	1,805	0,079
Post-test	37	101,86	16,00			

*The difference is important when $p < 0,05$.

When Table 11 is analyzed, it can be said that the difference between the pre-and post-test scores of experimental groups is not significant ($t_{36}=1,805$, $p>0,05$). However, when the metacognition level arithmetic averages of the experimental prospective teachers are perused, it is remarkably that there is an improvement in the metacognition skill levels at the end of the teaching.

Findings Associated with the Sixth Sub-Problem

In the sixth sub-problem, it was aimed to determine whether the difference between the metacognition pre-test and post-test scores of the control group prospective teachers was statistically significant. The outcomes obtained by using paired sample t-test are given in Table 12.

Table 12. Paired Sample t-Test Outcomes Regarding the Comparison of Metacognition Pre-test and Post-test Scores of Control Group

Tests	N	\bar{X}	S	sd	t	p
Pre-test	42	103,38	11,67	41	0,076	0,940
Post-test	42	103,50	10,85			

*The difference is important when $p < 0,05$.

Considering the data in Table 12, it can be said that the difference between the pre-and post-test scores of control group is not significant ($t_{41}=0,706$, $p>0,05$). When the metacognitive arithmetic averages of the control group prospective teachers were evaluated, it was determined that there was a little improvement in metacognition skill levels at the end of the teaching.

When the metacognition pre-test and post-test findings and arithmetic averages of both groups of prospective teachers in Table 11 and Table 12 were perused, it was found that there was no significant difference in the metacognition skill level as a result of the different teaching processes applied to both groups. However, considering the metacognitive pre-test and post-test arithmetic averages of both groups, the improvement in the metacognitive skill level of the experimental group was found to be higher than the metacognition skill level of the control group.

Discussion and Conclusion

According to the findings of the academic success pre-test, the items to which experimental group gave the most incorrect answers were found to be related to the subjects

of the passage of substance through the cell membrane, cellular respiration, and sense organs (nose), respectively. The items that the control group gave the most wrong answers in the academic achievement pre-test are related to photosynthesis and the transfer of substances through the cell membrane, respectively. When the academic success post-test data of both groups, who went through different teaching processes, were examined, a decrease was discovered in the percentages of the abovementioned items, which were mostly answered incorrectly in the pre-test. However, even if the percentages of the items related to the passage of substance through the cell membrane, cellular respiration, sense organs and photosynthesis to be answered incorrectly decreased, more than 50% of the prospective teachers were observed to answer the related items in these subjects incorrectly in the post-test. Therefore, it can be mentioned that prospective teachers have misconceptions in these subjects and experience difficulty in learning. Hence, it was seen as a result of the literature review that teaching the afore-stated subjects was difficult, and there were studies revealing that there were misconceptions in these subjects in general (Çapa, 2000; Çokadar, 2012; M. H. Güneş & Güneş, 2005; Harman, 2014; Konuk & Kılıç, 2002; Pamungkas, Saputro, & Mulyani, 2019; Tekkaya & Balcı, 2003). In a study conducted by M. H. Güneş and Güneş (2005) to examine the comprehension difficulties experienced by primary education 7 and 8th-grade students and their causes in the subjects of Biology, respiration and photosynthesis are shown as a difficult subject for students to understand. In addition, in another study carried out by Dikmenli, Türkmen, Çardak and Kurt (2005), it is stated that there are countless studies on individual misconceptions in the Biology education, however, photosynthesis and respiration appears as one of the three prominent subjects when the misconceptions addressed by those studies are categorized. In the experimental study executed by Harman (2014) without a control group, as mentioned, they detected via the POE teaching method that prospective science teachers had several misconceptions about the passage of substance through the cell membrane, and they found an opportunity to correct these misconceptions.

Considering the post-test data regarding the academic success of groups, both groups have the highest percentage of incorrect answers in the same item related to the urinary system. It can be said that the pre-service teachers' misconceptions about the excretory system caused the most mistakes in this item by both groups. Plus, the abstract nature of the concepts in the urinary system may make it difficult to learn the subject by complicating the comprehension of the system functioning by the prospective teachers. In the study where the subjects perceived by prospective science teachers as difficult, their reasons and solution proposals were examined according to their motivations for science by Fettahlıoğlu, Kaya and Gülnaz (2019), one of the subjects perceived as the most difficult ones in the field of Biology seemed to be the systems in our body. Prospective teachers stated that the reasons behind the non-comprehension of these subjects were the abstract form of the subjects and the lack of basic knowledge and suggested concretizing the abstract concepts with different teaching methods and techniques while teaching and first giving simple ones and then the complicated ones. In the literature, some studies conducted on students' learning difficulties in Biology indicate that the urinary system is a difficult subject to learn (Bahar, 2001, as cited in Özatlı & Bahar, 2010, p. 12; Bahar, Johnson, & Hansell, 1999; Özatlı, 2006). In a study by Bahar, Johnson and Hansell (1999), the difficulty index of the urinary system was determined as "5,3" whereas, in another study conducted by Bahar (2001), it was found to be as "18,7"; it was mentioned as one of the most difficult subjects to learn in Biology education (Özatlı & Bahar, 2010). In the research conducted by Özatlı (2006), in order to identify the subjects perceived by students as difficult ones in Biology lessons and determine the cognitive structures in the urinary system with new techniques, the difficulty indices of 23 out of 53 subjects were found to be 20% and above. The difficulty index of "Excretion and Kidney Functions" was found as



24.58%. As the reasons behind the non-comprehension of the subject, 20 students who perceived this subject as a difficult one mentioned non-use of visual materials in the lesson, no experiments, adoption of the direct instruction technique in the lessons in general, the abstract, verbal and memorization-based structure of the Biology course, the confusing nature of "the Urinary System" and not being able to participate in the course actively in the interviews. As a result, the adoption of the direct instruction method only by using materials like books and whiteboard, without any experiments, to teach the basic biology subjects in the primary and secondary education prevents meaningful learning. Thus, misconceptions in primary and secondary educational periods influence the university education as well (M. H. Güneş & Güneş, 2005; Lewis & Wood-Robinson, 1998). Both groups had the highest incorrect answering percentage in the same item related to the urinary system, which might result from the fact that this item was specifically based on the ability to read and interpret graphs. Accordingly, many studies conducted at different levels of education from primary education to university put forward that students' abilities to read, interpret and compare graphs are inadequate (Belser, 2009; Coleman, McTigue, & Smolkin, 2011; Demirci & Uyanık, 2009; Özmen, Güven, & Kurak, 2020; Phage, Lemmer, & Hitge, 2017; Sülün & Kozcu, 2005; Tekerek & Cebesoy, 2017). Deficiencies in the abilities of reading, interpreting, and comparing graphs affect the success of the students especially in Physics and Biology, as observed in various studies (Aydan & Dönel Akgün, 2019; Aydın & Delice, 2007; Demirci & Uyanık, 2009; McDermott, Rosenquist, & van Zee, 1987; Tekerek & Cebesoy, 2017). Graphs, which enable the visual summarization of complicated data, are used at every stage of scientific process skill from basic process skills (data recording, communication etc.) to combined process skills (data interpretation etc.). Thus, this item, which is related to the ability to read graphs, may have been answered incorrectly by both groups, because the scientific process skills of the previous prospective teachers at former educational levels could not be improved adequately. Most studies on the ability to read graphs state the importance of cooperation with different disciplines and inclusion of achievements related to graphs in every teaching level in order to improve these skills (Aydan & Dönel Akgün, 2019; Gültekin, 2009; Karaca, 2010; Yayla & Özsevgeç, 2015).

According to the post-test findings of the academic success test obtained from the research, there was no significant difference between the experimental group, for whom worksheets enriched with concept cartoons were used, and the control group, in which prospective teachers gave a lecture according to the 5E model. The fact that teaching was limited to four weeks, prospective teachers in the experimental group came across teaching practices supported with concept cartoons for the first time and the practices in which the learner was active were used in teaching both groups may have an effect on obtaining such a result from the study. There are many studies in the literature similar to this result obtained from the research (Balım, İnel, & Evrekli, 2008; Baysarı, 2007; Çiçek, 2011; Demircioğlu, Yılmaz, & Demircioğlu, 2016; Göksu, 2012; Güngör, 2018; Sayın, 2015). In Güngör's (2018) quasi-experimental study conducted to determine the effect of using concept cartoons in the unit "Human and Environment" on the academic success of primary education 7th-grade students, lessons were taught with concept cartoons in the experimental group and with the traditional teaching method in the control group for two weeks. No significant difference was observed between the students in both groups in terms of academic success as a result of the teaching. In the study conducted by Demircioğlu, Yılmaz and Demircioğlu (2016), the effect of using concept cartoons on academic success in the teaching of Electrochemical Cells was researched. The subject of Electrochemical Cells was taught with concept cartoons in the experimental group and with the traditional teaching method in the control group. According to the results of the academic success post-test performed, no significant difference was

observed between the university students in both groups in terms of academic success.

According to the findings obtained in this study, both groups' academic success was statistically similar before teaching. However, an increase was detected in the arithmetic means of both groups in the academic success post-test performed at the end of the 4-week teaching. This may result from the student-centered structure of the activities in the teaching of both groups. In the literature, there are many studies suggesting that student-centered activities are effective in increasing academic success (Arslan, 2016; Doymuş, Şimşek, & Bayrakçeken, 2004; Gömleksiz & Biçer, 2012; İsmail, 2005; Kara Yılmaz, 2017; Korkut, 2006; Şahin, Cerrah, Saka, & Şahin, 2004; Telli, Yıldırım, Şensoy, & Yalçın, 2004; Tokcan & Alkan, 2013). The study carried out by İsmail (2005) to investigate the effect of the student-centered science teaching on student's success was conducted with the quasi-experimental method. Student-centered teaching was applied on the students in the experimental group and the traditional teaching method was preferred for the students in the control group. In the study conducted, it was seen that the experimental group with student-centered education was statistically more successful.

In the study, although the groups were similar in terms of academic success before the teaching, the arithmetic mean of the experimental group was found to be lower than that of the control group. When the academic success post-test findings of both groups were examined, the arithmetic mean of the experimental group was found to be higher than that of the control group. This shows that there was a higher increase in the academic success mean of the experimental group as a result of the teaching processes applied for both groups. Thus, the fact that the study was carried out in four weeks and prospective teachers in the experimental group came across concept cartoon practices in this study for the first time can be said to prevent the emergence of a statistically significant difference in academic success in favor of the experimental group.

Considering of the analyses, no significant difference was found at the end of the teaching process in both groups, which had no significant difference between them in terms of the metacognitive level before the teaching. However, a higher increase was observed in the experimental group when the arithmetic means of metacognitive skill levels of both groups before and after the teaching were compared. Accordingly, limitation of the teaching period to four weeks restricted the increase in the metacognitive skills of the prospective teachers in the experimental group, who were being taught with worksheets enriched with concept cartoons. In the study conducted by Balım, Evrekli, Kaçar, Ormancı and Türkoğuz (2014) on concept cartoons, opinions of the teachers and students were obtained about the implementation on secondary school 6th-grade students by developing concept cartoons for the unit "Substance and Heat". Teachers who used the developed concept cartoons stated that concept cartoons were useful for creating an environment for discussion, enabling students to see their own mistakes, and concretizing the information. Students, on the other hand, expressed that teaching with concept cartoons helped them be aware of their own thoughts, evaluate their learning, understand scientific subjects/concepts in a better way, express their alternative thoughts related to them and learn by associating their knowledge with daily life. Hence, concept cartoons can be said to help individuals evaluate and control their own learning. According to Reeve and Brown (1985), metacognition is defined as individuals' guidance and control of their own cognitive process. In the literature, no studies that examined the effect of concept cartoons on metacognitive skills have been encountered. But in some studies, concepts such as motivation, attention and attitude are said to affect the individuals' metacognitive skill, which is the ability of controlling knowledge and thoughts (Demirci,



2016). According to Zoller (1993), metacognitive skills have a scope covering the skills such as critical and systematic thinking, asking questions, problem-solving, analysis and evaluation, synthesis and decision-making. In this context, the National Research Council draws attention to students' awareness of their pre-knowledge, explanation of the reasons behind their perspectives, discussion, and comparison of their ideas for K-8 teachers so that metacognitive teaching can be achieved in the science teaching (National Research Council, 2007). Keogh and Naylor (1999), on the other hand, suggest the concept cartoons as a significant strategy in terms of students' comparison of their own ideas with others'. Accordingly, concept cartoons may affect several skills such as inquiry, logical thinking skills, motivation, attitude, self-competence, and anxiety, which are related to metacognitive skills. Thus, it has been seen in the literature review that there are many studies investigating the effects of concept cartoons on attitude, motivation, self-competence, anxiety, affective and cognitive characteristics, which influence the metacognitive skills (Baysarı, 2007; Evrekli, İnel, & Balım, 2011; Gölgeli, 2012; Gölgeli & Saraçoğlu, 2019; İnel & Balım, 2011; Kaptan & İzgi, 2014; Karakuş, 2019; Özçelik, 2019; Özyılmaz Akamca & Hamurcu, 2009; Şengül, 2011; Şengül & Aydın, 2013; Şenocak, 2018; Taşkın, 2014; Yılmaz, 2013; Yolcu, 2013). Some results obtained from this research are similar to the results of these studies in the literature.

Yolcu (2013) discovered in a study on primary education 7th-grade students that concept cartoons created a significant difference in favor of the experimental group in terms of academic success and attitude, however, no statistically significant difference emerged although their scores of logical thinking skills increased. In the study, it was stated that concept cartoons needed to be applied for a longer time so that a significant difference could be observed in the improvement of logical thinking skills. In the study conducted by Evrekli, İnel and Balım (2011) on 6th-grade students by using practices supported with concept cartoons and mind maps, a significant difference was observed in students' academic success and motivations in favor of the post-test. However, no statistically significant difference occurred between the pre-test and post-test scores although there was an increase in the post-test scores of attitude and inquiry-based learning skills. In Baysarı's (2007) study, it was discovered that concept cartoons did not create any significant difference in terms of academic success and attitude although their positive effects were observed on the elimination of 5th-grade students' misconceptions. In the study, this is attributed to the application of concept cartoons on the experimental group within a period as short as two weeks. Due to the inclusive structure of metacognitive skills containing several skills, Case and Gunstone (2002) express that improvement of these skills is time-consuming and requires efforts of both teachers and students. In line with the results obtained in this study, the teaching process should be longer for the improvement of the metacognitive skills, so that teachers and students can understand and get used to the structure and the application method of the concept cartoons.

Suggestions

Suggestions made on the basis of the study results are presented below:

- The aim of the course of Science Teaching Laboratory Applications I-II given in the education faculties is to increase the subject matter knowledge of the prospective teachers and to gain theoretical and practical knowledge in the application of the special teaching methods and techniques used in science education. Therefore, practical

applications of different special teaching methods can be demonstrated in Science Teaching Laboratory Applications I-II course.

- In this study and in the relevant literature, it has been concluded that concept cartoons have positive effects on academic success and misconceptions. Thus, concept cartoons can be utilized for teaching Physics, Chemistry and Biology, lessons which contain quite many abstract concepts.
- The fact that prospective teachers were not used to the teaching practices with concept cartoons and the implementation was carried out in a period as short as four weeks prevented the emergence of a significant difference between the groups in the improvement of metacognitive skills, which has an inclusive structure. Hence, it can be recommended to keep the teaching period longer in similar studies, which will be conducted in the future on the effect of teaching with concept cartoons on metacognitive skills, and to study some dimensions of the metacognitive skills.
- It was observed in the literature that most studies conducted on concept cartoons had samples consisting of primary or secondary school students. Concept cartoons can be used for teaching every age group in order to reduce anxiety and develop positive attitude for the courses in the field of Science (Physics, Chemistry and Biology). Therefore, different studies can be conducted with prospective teachers regarding concept cartoons.
- The subject area of this study is broad since 15 concept cartoons were used for 11 Biology subjects determined in the study. In this aspect, detailed studies on a single subject can be carried out in future studies on concept cartoons.
- In the studies to be conducted, concept cartoons can be developed on the subjects of Physics and Chemistry in the Science Teaching Laboratory Applications course and their effects on affective variables such as attitude and motivation can be investigated.

Footnote

This article is produced from the master thesis "The effect of prediction-observation-explanation practices supported by concept cartoon towards biology subjects on academic success and metacognitive skills of science prospective teachers".

6. References

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