The Effect of the Flipped Classroom Model on Understanding and Access to the Nature of Science by Students

Merve KAYA
mervee_kok07@hotmail.com

Dr. Öğr. Üyesi Fatih Serdar YILDIRIM
fsyildirim@akdeniz.edu.tr

ABSTRACT
The purpose of this study is to examine the effect of the flipped learning model (Staker & Horn, 2012), which is one of the types of rotation model in the sub-level of blended learning models, on students' understanding of the nature of science and their achievements. In the study, the mixed research method, which allows the quantitative and qualitative research methods to complement each other with the combined use of these methods, and the pretest-posttest control group design were used. The sample required for the application consists of 45 students, 22 in the experimental group and 23 in the control group, studying in the seventh grade in a public school in the Kepez district of Antalya province. While the application was carried out with the experimental group students following the flipped classroom model and the methods prescribed in the science program, it was carried out with the control group students following the methods prescribed in the science program for seven weeks. In order to obtain quantitative data, the VNOS-C scale developed by Lederman (2002), graded scoring key developed by Özcan (2013) and the Achievement Test prepared by the researcher, and the semi-structured interview form prepared by the researcher to obtain the qualitative data, were applied to the students, and the research implementer was interviewed. The data in VNOS-C used in the study were analysed by the content analysis method and converted into quantitative data under the guidance of the graded scoring key. Transformed data were analysed with the non-parametric Mann Whitney-U test, and the data obtained from the Achievement Test were analysed with the independent sample t-test. The data obtained from the Semi-Structured Interview Form and Teacher Interview Form were analysed by content analysis. In line with the quantitative findings obtained from the studies, it was determined that the application of the flipped classroom model positively affected the experimental group students' understanding of the nature of science and achievement. In line with the qualitative data obtained from the study, it was determined that the application of the flipped classroom model positively affected the attitudes of the students towards the course and the research implementer also had a positive opinion about the model, and it was determined that the application of the model would be more effective by improving some technical infrastructure.

This study belongs to Kaya's (2021) Master's thesis titled *The Effect of the Flipped Classroom Model on Students' Understanding of the Nature of Science and Achievement*.

INTRODUCTION
Science has undergone a rapid transformation as of the early 1900s and has become one of the most significant changes in world history. The change experienced has contributed to both the advancement of technology and the way individuals shape their views on life by affecting their mentality (Doğan, Çakıroğlu, Bilican & Çavuş, 2012; Doğan-Bora, 2005). Science aims to make individuals understand themselves and make sense of the life cycle that exists in the world (NRC, 1996; MEB, 2005). It is essential for individuals to be able to interpret the formation of scientific knowledge and its source so that they can make sense of science and reach the desired results (Lederman, 2004). For this reason, countries have given importance to science education and have changed the vision and mission of the science program. In our country, the science curriculum was changed in 2004, and its vision was determined as raising scientifically literate individuals (TTKB, 2005; TTKB, 2013). It is essential to make sense of the nature of science to become scientifically literate individuals. Because, according to Lederman and Niess (1998), the individual '*discovers the nature of science, understands its scope, can use scientific process skills and comprehends the importance of technology*'.

Since the 1950s, the relationship of science with society and technology has gained importance, and new approaches have been introduced in science education (NRC, 1996; Bacanak, 2002; Bacanak, Karamustafaoğlu & Sacit, 2003). At the same time, the development of technology has been associated with the science education given to children during the school period. It has taken its place in the literature that the systematic science education given to the students will positively affect the development of their thinking skills by adapting with ease

to the changes and innovations in the technological field with science education (Korkmaz, 2002). Within the framework of the studies carried out in the field of education in recent years, new regulations related to education have been included in our country. Various approaches have been identified with the active participation of students, considering the latest regulations (İnel & Balım, 2010). With the changes in learning and teaching methods, different teaching strategies and methods have emerged, and it has been tried to facilitate the learning-teaching process and make learning permanent (Çukurbaşı & Kıyıcı, 2017; İşman, 2011; Kertil, 2008; Yıldırım, Yıldırım & Çelik, 2018). As a result of the examination of educational studies carried out by blending with technology, it has been observed that different learning approaches are formed with the use of various technological tools (Akgün & Atıcı, 2017; Yavuz & Coşkun, 2008; Ünsal, 2018; Kaya, 2018; Bolat, 2016; Görü-Doğan, 2015). Learning in the virtual environment, which started with distance education, later turned into web learning, e-learning, blended learning, mobile learning and finally flipped learning methods (Ünsal, 2018). The flipped learning method was introduced by Bergmann and Sams (2012) in order to provide permanent, effective and high-level learning in the course by swapping the lesson and homework in classical learning (Karaca & Ocak, 2016; Tucker, 2012; Staker & Horn, 2012; Musib, 2014). Various concepts (such as transformed classrooms, flipped classrooms, transformed learning, flipped learning) are used in the literature for the flipped learning model (Hayırsever & Orhan, 2018). It is thought that this is due to the different naming of the flipped learning model in the studies prepared by Lage, Platt and Treglia (2000) and Baker (2000) around the same time (Demiralay & Karataş, 2014). According to Guan (2013), the flipped learning model has been on the agenda for about twenty years, and it has been stated that the process in this model is realized by making pre-readings before coming to the lesson and that the development of technology has caused the preparation for the lesson to move from the reading dimension to different dimensions (Torun & Dargut, 2015). The main goal of the theory is to increase the quality of face-to-face education by using the time spent at school with maximum efficiency (Sam & Bergmann, 2013; Öztürk & Alper, 2018).

With the development of technology, the classical learning model has left its place to the contemporary learning model, and thus different teaching methods and techniques have emerged. Considering that today's students are the generation Z, it has become inevitable that classical curricula are insufficient to meet their differing expectations, and for this reason, curricula should be redesigned by allowing the use of innovative technologies (Somyürek, 2014). It is in the literature that the mentioned generation Z can adapt to new learning methods with ease and use technology easier compared to previous generations (Göğebakan Yıldız, Kıyıcı & Altıntaş 2016). On the other hand, understandings about the nature of science constitute the basic element of the notion of science-technology-society, which is one of the sub-dimensions of science literacy (Lederman, 2004). Thus, students use scientific knowledge to make it meaningful, structure knowledge, and easily identify the source and limits of knowledge (Köseoğlu, Tümay& Budak, 2008). When the literature is examined, it has been determined in many studies that students and teachers do not have a supportable understanding of the nature of science (Lederman, 1992; Köseoğlu, Tümay & Budak, 2008). On the other hand, it has been determined that the nature of science and the flipped learning model are not studied together in the literature. Based on this situation, it was planned to conduct this research based on the seventh-grade students' *Particle Structure of Matter* unit (Unit 4), the subject of *Atom* (Subject/Concept 1), *questioning how the ideas about the concept of the atom have changed from past to present* outcome (Outcome 2) (MEB, 2018). When the 2018 Science Curriculum (MEB, 2018) is examined, it is thought that the flipped learning model will be effective in the process of raising all individuals as science literate. In this context, the study aims to examine the effect of flipped learning model (Staker & Horn, 2012), which is one of the types of rotation model, a sub-dimension of blended learning models, on students' understanding and achievement of the nature of science.

The Problem of Study

In line with the purpose of the research;

Does the flipped learning model have a statistically significant difference in students' understanding of the nature of science and achievement?

1. Does the flipped classroom model have an effect on students' understanding of the nature of science?
2. Does the flipped learning model have an effect on students' achievement?

questions will be answered.

METHOD

Research Model

The method in which quantitative and qualitative data are used together to explain and make sense of the research problem in more detail is called the mixed research method (Creswell, 2017). In the study, the mixed research method, which allows the quantitative and qualitative research methods to complement each other with the combined use of these methods, and the pretest-posttest control group design were used. In order to obtain

quantitative data, the VNOS-C scale developed by Lederman (2002) and the Achievement Test prepared by the researcher, and the semi-structured interview form prepared by the researcher to obtain the qualitative data, were applied to the students, and the research implementer was interviewed.

Study Group

A situation was selected from many situations in the universe considering the research problem, and a sample selection was made with the typical situation sampling method (Büyüköztürk, Kılıç-Çakmak, Akgün, Karadeniz & Demirel, 2017) in the form of collecting information on this situation. The sample required for the study consists of 45 students, 22 in the experimental group and 23 in the control group, studying in the 7th grade in a public school in the Kepez district of Antalya province. While selecting the experimental and control group students, the selection was made based on the students' report card grades before the pandemic process.

Table 1 t-Test Scores for Students' Report Card Grades

Test	Group	N	$\bar{X}$	SS	P
Report card grades	Experimental Group	22	82.50	16.01	.14
Report card grades	Control Group	23	74.78	18.91	

According to the results of the independent sample t-test performed in line with the data obtained from the students' report card grades, between the mean of report card grades of the experimental group ($\bar{X}$=82.50, SS=16.01) and the mean of report card grades of the control group ($\bar{X}$=74.78, SS=18.91), there was no statistically significant difference (p>.05). As a result of the analysis, it was determined that the students of the experimental and control groups were equal in terms of achievement.

Data Collection Tools

The data collection tools applied to the students in the study groups in this research are as follows.

1) Views of Nature of Science Questionnaire-VNOS-C (Lederman, 2002)
2) Graded Scoring Key (Özcan, 2013)
3) Semi-Structured Interviews
4) Achievement Test
5) Teacher Interview Form

Application and Data Collection

Before the research, the Science teacher, who was the application implementer, was given information about the application process by the researcher. Two equivalent classes were determined for the application by considering the student grades of last semester before the pandemic process. One randomly assigned class was determined as the experimental class and the other class as the control class. Views of Nature of Science Questionnaire (VNOS-C) was applied to the selected experimental and control classes as a pre-test before the application. The research implementer taught the course with the control group students as required by the curriculum. With the experimental group students, the video contents, which were determined in line with the units and outcomes, were sent to the students before each outcome, and the lessons were taught by enabling the students to watch the videos.

With the experimental group students, the lessons were taught as required by the flipped classroom model, and in the online classes held due to the pandemic; question-answer, fill-in-the-blank, multiple-choice questions, simulations and online activities were done about the topics and outcomes prepared by the teacher. After the application, VNOS-C and Achievement Test were applied to the experimental and control group students as a post-test. In addition to these measurement tools, a Semi-Structured Interview Form was applied to the experimental group students. The application implementer was also asked to fill in the Teacher Interview Form to determine the participation levels of the experimental group students.

Table 2 Measurement Tools Used in Data Collection Process and Sample Relationship

Application Process	Experimental Group	Control Group
Measuring Tools Used Before Application	Pre-Test VNOS-C	Pre-Test VNOS-C
Measurement Tools Used After Application	Post-Test VNOS-C Achievement Test Semi-Structured Interview Form Teacher Interview Form	Post-Test VNOS-C Achievement Test

Data Analysis

Strauss and Corbin (1990) stated that the data should be grouped in order to perform content analysis on the obtained data. Three coding types were determined as; coding made according to the concepts determined before the application, coding made in line with the concepts obtained from the data, and coding made in line with a scope (as cited in Yıldırım & Şimşek, 2011, p.229). In this research, the data obtained from VNOS-C were used with the coding technique made according to the concepts specified before the application, which is one of the coding types expressed by Strauss and Corbin (1990).

Since the Views of Nature of Science Questionnaire, which was used as a data collection tool in the research, is a measurement tool used for qualitative research, the analysis of the data obtained with this measurement tool was converted into quantitative data with the content analysis method. The analysis of the converted data was provided by using quantitative analysis methods (Mann Whitney U test from non-parametric statistics test) through the SPSS package program. Semi-Structured Interview Form, another data collection tool used in the research, is a measurement tool used for qualitative research. For this reason, for the analysis of the data obtained from this measurement tool, content analysis was carried out using the coding technique made in line with the concepts obtained from the data, which is one of the coding types expressed by Strauss and Corbin (1990).

The Achievement Test applied to students is a measurement tool used in quantitative analysis methods. In order to determine the effect of the application on the achievement of the students, the analysis of the data obtained from the measurement tool should be calculated as points. For this reason, the analysis of the data obtained from this measurement tool was carried out using the SPSS package program. Within the scope of the study, the researcher determined a generalizing question within the scope of the interview form for the Science teacher, who is the application implementer, and the teacher's views about the process were obtained by deriving sub-questions during the interview in line with the answers received. The reliability and validity of the interview form prepared by the researcher were obtained by taking expert opinion.

RESULTS

Findings and Comments on Students' VNOS-C Pre-Tests

Content analysis of the qualitative data obtained from VNOS-C was carried out in line with the specific concepts before the application, and the data were scored using the graded scoring key developed by Özcan (2013) to evaluate the data obtained from the VNOS-C, and the data was converted into a quantitative data format. In the graded scoring key, codings are discussed under three headings. Data were coded as unacceptable answers (0 points), partially acceptable answers (1 point), and acceptable answers (3.50 points).

Under this heading, the findings of the data obtained from the students' pre-tests of the VNOS-C, which were analysed using the Mann Whitney U test, which is a non-parametric statistical test, are included.

Table 3 Mean Ranks for Students' VNOS-C Pre-Tests

Test	Group	N	MeanRank	Sum of Ranks
Pre-test	Experimental group	22	23.86	525.00
Pre-test	Control group	23	22.17	510.00
Pre-test	Total group	45		

The Mann-Whitney U test was used to determine whether the scores of the groups from the pre-test differed significantly. The mean rank (MeanRank) and the sum of the mean ranks (Sum of Ranks) of the groups are as seen in Table 3.

Table 4 Mann Whitney U Test Results of Students' VNOS-C Pre-Test Data

	Pre-test
Mann-Whitney U	234.000
Wilcoxon W	510.000
Z	-.443
Asymp. Sig. (2-tailed)	.658

According to the Mann-Whitney U test results in Table 4, there was no significant difference between the mean rank of the groups (Z=-0.443, P>0.05). According to this result, there is no significant difference between the pre-test mean scores of the groups.

Findings and Comments on Students' VNOS-C Post-Tests

Under this heading, the findings of the data obtained from the students' post-tests of the VNOS-C, which were analysed using the Mann Whitney U test, which is a non-parametric statistical test, are included.

Table 5 Mean Ranks for Students' VNOS-C Post-Tests

Test	**Group**	**N**	**MeanRank**	**Sum of Ranks**
Post-test	Experimental group	22	33.91	746.00
Post-test	Control group	23	12.57	289.00
Post-test	Total group	45		

The Mann-Whitney U test was used to determine whether the scores of the groups from the post-test differed significantly. The mean rank (MeanRank) and the sum of the mean ranks (Sum of Ranks) of the groups are as seen in Table 5.

Table 6 Mann Whitney U Test Results of Students' VNOS-C Post-Test Data

	Post-Test
Mann-Whitney U	13.000
Wilcoxon W	289.000
Z	-5.471
Asymp. Sig. (2-tailed)	.000

According to the Mann-Whitney U test results in Table 6, there is a significant difference between the mean rank of the groups (Z=-5.471, P<0.05). According to this result, there is a significant difference between the post-test mean scores of the groups in favour of the experimental group.

Findings and Comments on Students' Achievement Tests

In this title, the findings and comments of the Achievement Test, administered to the students after the application, are given.

Table 7 t-Test Scores on Students' Achievement Tests

Test	**Group**	**N**	**$\bar{X}$**	**SS**	**p**
Achievement test scores	Experimental Group	22	88.18	11.47	.00
Achievement test scores	Control Group	23	62.95	20.93	.00

After the planned application process, according to the results of the analysis taken from the Achievement Test to determine the student achievement, the mean of the test score was calculated ($\bar{X}$=88.18, SS=11.47) for the experimental group and ($\bar{X}$=62.95, SS=20.93) for the control group. In other words, there is a statistically significant difference between the experimental and control group students in favour of the experimental group (p<.05). In line with these results, it is concluded that the teaching model with the experimental group students has a positive effect on the students' achievement compared to the teaching model with the control group.

Findings and Comments on the Semi-Structured Interview Form of the Students

The analysis of the data obtained from the Semi-Structured Interview Form was made with the content analysis method. The analysed data were grouped by dividing into two themes. These themes are the effects of science teaching with flipped classroom model on students' cognitive domains and affective domains. The mentioned themes were categorized as cognitive domain and affective domain.

The findings of the cognitive domain theme support the quantitative findings of the study. Quantitative findings indicate that the application of the flipped classroom model positively affects students' achievement. The qualitative findings collected during the research process also support the quantitative findings.

Thanks to teaching with the flipped classroom model, since students who have trouble making connections between the information they encounter in the classroom for the first time have more or less information about the concepts through the videos about the subject sent by the teacher before the lesson, it becomes inevitable that the learned subject will be more meaningful. Student opinions on this situation are given below.

Student 6: …What was written in the book and the videos I watched on the computer were useful in the lesson. At first, my mother forced me to watch it because it was homework. I always raised my hand because I knew the subject beforehand. Good thing my teacher sent us those videos. I understood the lesson better.
Student 10: …There is little internet in our house. It runs out quickly. I could barely watch the videos my teacher sent. But my teacher made me rewatch the videos they sent in the live lesson, and then they repeated it, I understood the subjects immediately…
Student 15: …While watching the video, I thought we were not going to have a live lesson with the teacher. I watched it as such. But when my teacher asked questions in the lesson, I realized that I understood a little of what I was watching. I was barely involved in the class. For the first time, I understood better in this unit. Even the questions were very simple.
Student 18: … I have a cousin. They go to another school. They asked a question about this subject that they couldn't solve. I just solved that question. I learned the subject better.
Findings on the affective domain: Students' interest and participation in science lessons increased with the flipped classroom model. Student opinions on this situation are as follows.
Student 1: …I never liked science class, but now I love it. Because I answered my teacher's question in the lesson and my teacher said well done to me. They also said always attend the class like this… I really liked these words.
Student 4: …I wish lessons were like this all the time. My teacher solves more questions and experiments in class. I loved this application. I am very happy when my teacher makes an experiment...
Student 10: …When I told my teacher in class that I didn't watch the video, they immediately showed the video again for me in class. I was very happy...
Student 22: …I hope our lessons will always be like this. Science class means experiment. We have been doing more activities…

Findings and Comments Obtained from the Interview with the Teacher
At this stage, a general question was asked as 'What are your thoughts about the application process?' in order to determine the thoughts of the application implementer about the application. In line with the answer to this question, a detailed interview was provided by the researcher. The findings obtained from the Teacher Observation Form are stated as follows.

Table 7 Findings and Comments Obtained from the Interview with the Teacher

Preparation Phase of Implementing the Flipped Classroom Model	● I need to have all the necessary information on the subject. ● I believe that the application should be used in face-to-face learning to increase its effectiveness. ● For the application to run smoothly, I believe that the students in the experimental group should have tools such as computers, tablets and the internet.
Difference of the Flipped Classroom Model Application from Other Applications	● I think it is a new teaching model. ● I think the application process is not very difficult.
Views on the Flipped Classroom Model Application Period	● The selection of the preliminary information to be sent to the student before the lesson took a lot of time. ● It was difficult to track whether the students watched the videos or not.
Views of the Flipped Classroom Model Application Process	● The students who watched the videos actively participated in the lesson. ● It helped students of all levels to have more or less knowledge of the concepts that the videos used were clear and understandable. ● Students who did not attend the lesson were also helped to reflect on the subject. ● The majority of the class participated in the activities carried out with online education with pleasure and excitement.
Advantages of the Flipped Classroom Model Application	● During the application process, I did not have any difficulties catching up to the outcomes on time. ● I could easily attend to students individually. ● I was able to analyze students' learning. ● I was able to do more activities on the subject. ● It allows students to explore their own learning.
Disadvantages of the Flipped Classroom Model Application	● I made sure that the videos were watched by calling the students who did not watch the videos during the preparation phase of the lesson. ● During the filling process of the measurement tools required for the research by the students, I helped to collect the data in full by calling the students one by one. ● During the application process, I had difficulty in getting the students involved in the process because some students didn't have sufficient computers, tablets and internet equipment. ● There was a situation where students with limited internet followed the application process behind.

The data obtained as a result of the interview with the teacher were collected under six headings stated in Table 7. The most frequently discussed and the repeated issue of the Flipped Classroom Model application is that the application will be more effective in face-to-face learning, and students who do not have sufficient equipment for the application can be included in the process. The application implementer stated that the disadvantages experienced can also be eliminated with face-to-face learning.

In addition, in the interview with the application implementer, they expressed the following thoughts about the process in the cognitive domain.
Teacher: ...At first, I accepted it so that I could help the thesis student. How could I have known that there would be an incredible change in my students? Choosing the videos is a difficult process, but after my students learn better, the rest is empty. It is also simple to apply with students of all grades and levels…

In addition to this statement, the application implementer also has the following statements regarding the affective domain related to the process.
Teacher: ...Actually, I was scared at first, but when I saw that my lessons were more active and enjoyable, I decided to teach like this in every unit and class when the application period was over. Some students have technical infrastructure problems. I also make them watch the videos briefly before the lesson. Overall, I was satisfied with the application process. Due to the pandemic, I had difficulties in the application process and collecting data with distance education, but if we go back to the old system, there can be wonderful activities in the lessons...

CONCLUSION, DISCUSSION AND SUGGESTIONS

Conclusion and Discussion

In the study, the effect of the flipped classroom model on students' understanding of the nature of science and achievement were investigated. Under this title, it was supported by the literature, in line with the findings obtained from the study and within the framework of sub-problems.

In the research, the qualitative data obtained from VNOS-C were transformed into quantitative data by making content analysis with graded scoring key developed by Özcan (2013). The quantitative findings were analysed and interpreted in-depth. It was determined that the selected sample groups were equivalent with the VNOS-C applied as a pre-test. As a result of the planned application with the experimental and control group students, it was determined that the application of the flipped classroom model positively affected the students' understanding of the nature of science. There are many studies in the literature that support this result of the research. In one of these studies, conducted by Boran (2014), to investigate the effect of the argumentation-based science course on the views and epistemological beliefs of prospective science teachers about the nature of science, it was determined that there was a change in the views and epistemological beliefs about the nature of science in two out of three participants of the argumentation-based science education. A similar study was carried out by Çekbaş (2017). In this study, whose aim was to explain the effect of argumentation-based astronomy teaching on the nature of science, pseudoscience and epistemological beliefs of prospective science teachers, it was concluded that the argumentation-based astronomy teaching was influential in the separation of science from pseudoscience, epistemological beliefs and beliefs in the nature of science. In the study conducted by Gögebakan-Yıldız and Kıyıcı (2016), where the effect of the flipped classroom model used in the History and Nature of Science course on the academic achievement, metacognitive awareness, and epistemological beliefs of prospective science teachers was examined, the result that it increased the achievement and metacognitive awareness of prospective teachers in the classroom, but did not have a significant effect on epistemological beliefs, was seen as a different result from our study.

As a result of the literature review, no studies were found that used the variables of the flipped classroom model and the nature of science. However, the flipped classroom model is a technology-based learning model. In this context, similar to the results of the study, there are various studies in the literature in which there are positive changes in the epistemological beliefs of learners as a result of the use of technology in education (Elgatait, 2015; Harteis, Gruber, & Hertramph, 2010; Bendixen & Hartley, 2003). On the other hand, as a result of the literature review, various studies have been found that have similar results (Hibbard, Sung and Wells, 2016; MacKinnon, 2015; Prashar, 2015; Davies, Dean and Ball, 2013; Tune, Sturek and Basile, 2013; Wilson, 2013) to the study carried out.

The data obtained from the Achievement Test belonging to the research were analysed with the t-test. In line with the quantitative data analysed, it was concluded that the application of the flipped classroom model positively affected the achievement of the students in favour of the experimental group. Similar to this result of the study, in the study designed by Hava (2021) to determine students' perspectives, deep learning strategies and level of participation in the lesson on the flipped classroom model; it was found that the experimental group students used the deep learning strategy and their cognitive-affective levels more effectively than the control group students. Another study, which overlaps with the results of the study, conducted by Şahin (2020), to determine the effect of the flipped classroom model application on the academic achievement and attitudes of the students towards social studies courses, concluded that there was a statistically significant difference in achievement and attitude scores of students, in favour of the experimental group. In the same study, as a result of semi-structured interviews with students and parents, it was concluded that they generally liked the application of the flipped classroom model, they had positive feelings and thoughts towards the model, it positively affected the attitudes of the students towards the social studies course, and they wanted the application to become widespread. In the study of Akyol and Garrison (2010), in which the effect of the blended learning environment designed based on collaborative constructivism on students' learning was investigated, it was seen that the application made a significant contribution to students' learning. In addition, the study prepared by Banados (2006), which concluded that the use of an online interactive multimedia environment, which is one of the sub-types of blended learning environments, has a positive effect on students' English course success, supports the results of our study. As a result of the literature review, similar studies supporting the results of the achievement test used in the research were identified (Keskin, 2020; Koç-Akran & Bayrak, 2020; Say & Yıldırım, 2020; Yorgancı; 2020; Arslan & Kuzu, 2018; Çakır & Yaman, 2018; Akgün & Atıcı, 2017; Çukurbaşı & Kıyıcı, 2017; Sakar & Uluçınar-Sağır, 2017).

In line with the findings obtained from the content analysis of the data acquired from the Interview with the Teacher and the Semi-Structured Interview Form made with the experimental group students, it was concluded that the application of the flipped classroom model increased the participation of the students in the lesson. In addition to

this result, it was concluded that the application of the flipped classroom model was found to be interesting by the students, therefore, their interest in the science course and their motivation towards learning science increased. There are many studies in the literature that are similar to the results of the study. In the research conducted by Kaya (2018), in which the effect of the application of the flipped classroom model in mathematics teaching on the participation of eighth-grade students in secondary school was examined, as a result of the analysis made by considering the affective, cognitive and behavioural domains, it was determined that the level of participation of the students in the lesson was statistically significant in favour of the experimental group. Similarly, in the study conducted by Koçak (2019), in which the effect of the flipped classroom model application on the academic achievement of the students in the English course was examined, it was determined that the application increased the success of the students in favour of the experimental group. In addition to this finding, it was stated that the application increased the participation of the students in the class, and they also had positive opinions about the English course. On the other hand, in the studies conducted by Chen, Lambert, and Guidry (2010) and Albrecht (2006), in which the effect of the use of blended learning environments in the learning process on the participation of the students in the course and the effect on the development of the students' experiences was examined, it was determined that the use of internet-based learning technologies had a positive effect on the participation of the students in the course and learning outcomes. In addition to the aforementioned studies, as a result of the literature review, similar studies were found that support the conclusion reached in the research (Aslan, 2020; Say & Yıldırım, 2020; Şahin, 2020; Jeong, Canada-Canada & Gonzalez-Gomez, 2019; Biederman, 2018; Sağlam & Arslan, 2018; Şenel & Kahramanoğlu, 2018; Demirer & Aydın, 2017; Sarıtepeci & Yıldız, 2014).

Recommendations

Considering the findings and results obtained as a result of the study carried out, the following suggestions were presented to the researchers.

- The research was limited to the application of the flipped classroom model. Apart from this, studies can be carried out based on different learning models.
- Similar studies can be done using blended learning techniques.
- This study, which is limited to the sample group and unit of the research, can be applied to various grade levels and various units.

If the flipped classroom model is introduced more effectively to teachers through in-service training and various courses and to teacher candidates in education programs in education faculties, it can be used in different courses.

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