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The Effect of the Flipped Classroom Model on Students' Achievement, Problem-Solving Skills and Attitudes towards Physics Lesson*

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Abstract

The study explored the effects of the Flipped Classroom Model (FCM) application enriched with digital content and educational activities for the physics lesson on students' academic performance, problem-solving skills, and attitudes towards the physics lesson. The study employed the pretest-posttest control group quasi-experimental design. The study group of this research consists of 121 10th grade students, 59 of whom are experimental and 62 are control. In the study, the subject of "Pressure and Buoyancy" was taught according to the FCM in the experimental groups, while the lessons were carried out in the control groups using methods suitable for the 10th grade Physics Curriculum. Dependent and independent samples t-test analyses were used for the analyses of the pretest and posttest measurement data. The study findings revealed that the academic achievement, physics lesson performance, and attitude scores of the students in the experimental group, in which the FCM was used, were significantly higher than the scores of the students in the control group. No significant difference was found in the problem-solving skills scores between the experimental group students and the control group students.

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* This research is based on the master's thesis titled "The effect of using flipped classroom model in physics on learning products".

INTRODUCTION

Although face-to-face education is considered the most important characteristic of the learning process, the concept of distance education came into the picture with the use and spread of technological tools in the 19th century. The process, which started with the contribution of communication tools such as radio and television to education, continued with the use of computers and computer technologies. With the widespread use of the internet, online learning has come to the fore, and with mobile technologies, the boundaries of learning environments have been greatly expanded. It was put forward as a common view that the use of technology in education alone is not sufficient, just as traditional education cannot provide effective and efficient learning (Osguthorpe & Graham, 2003). At this point, one of the most possible solutions is considered to be "blended learning". Inadequacies in current learning experiences can be overcome by blended learning (Driscoll, 1994). One of these blended learning models is the Flipped Classroom Model (FCM).

The FCM, which is defined as the integration of communication technologies into education, is an instruction model bringing the activities that take place in the classroom to the outside and the activities that take place outside the classroom to the classroom. The FCM, in short, refers to the flipping of the time and place of the theoretical lectures and homework (Bergmann & Sams, 2012). While the theoretical lecture of the lesson is carried out at home with online recordings, in-class activities are divided into points that are not understood, additional activities, and repetitions. While wide implementation trials of the model were encountered in the 2000s, the researchers who conducted the earliest studies on its functional use were Bergmann and Sams (2012). The most popular contribution to the FCM was made by Khan in his TED talk titled "Let's use video to reinvent education", and the entrepreneur used the concepts of "flipping the classroom" and "flipped classroom" for the first time (Khan, 2011).

The FCM gained even more importance after the World Health Organization declared a pandemic as a result of the spread of the corona virus. Specifically, the model's presentation of the theoretical content to the students using technological materials was assessed as the only way to be followed after the closure of schools in all countries of the world due to the pandemic. Even after the effects of the virus are wiped out, these materials will still be available to students and teachers.

In many other studies, the effectiveness of the FCM on learning was examined using various methods, and these studies emphasized that the model's advantageous aspects are quite satisfactory (AlJaser, 2017; Arnold-Garza, 2014; Bergmann & Sams, 2012; Cole & Kritzer, 2009). In a study by Wiginton (2013), the effects of three different learning environments, namely Flipped Active learning environment, Flipped Mastery learning environment, and traditional learning environment, on student achievement were investigated. In the same study, students' experiences and how students' learning styles affect their learning environment preferences were also investigated. The results showed that the math achievement scores of the groups that were in the Flipped Active learning environment and Flipped Mastery learning environment were significantly higher than the math achievement scores of the group that was exposed to traditional instruction. Another study examined whether the FCM has an effect on the learning of linear algebra subjects in engineering sciences. The study revealed that the students who were taught using the FCM were more successful than the students who were taught with the traditional model. It was also reported that the students had positive thoughts about the FCM and found the lesson materials educational and instructive (Love et al., 2014). In another study, Butt (2014) aimed to determine university students' views on the teaching activities of a lesson designed according to the FCM. The study showed that the students' views on the model were positive. The participating students stated that being able to access the materials in advance enabled them to prepare for the class, they were able to do unlimited repetitions at home, their learning was easier, and their learning quality and success increased. In the study conducted by Gross et al. (2015), the effectiveness of the FCM was examined in terms of the relationships between student participation, student satisfaction, and academic performance. They concluded that there was a high level of student participation and lesson satisfaction in the classroom where the FCM was used. In addition, Yestrebsky (2015) examined the effectiveness of the FCM on the chemistry achievement of large groups. The study sample consisted of students who were majoring in science and engineering. According to the study results, the FCM significantly increased the achievement in Group A and Group B which had high achievement levels, the model had no effect on Group C and it actually decreased the achievement level in the group with already low academic achievement. Furthermore, another study determined that the digital technological materials developed for the classroom in which the FCM was used enabled students to have positive attitudes about their learning and teaching experiences outside the classroom (Long et al., 2016). Researchers' interest in the subject has continued in Turkey and in other countries. Kazu and Yalçın (2022) reported the existence of 58 studies published in Turkish and English between 2007-2021, investigating the effect of the flipped classroom model on academic achievement.

In the literature related to the field, there are studies revealing that the effectiveness of the FCM on learning and some variables is not significant (Howell, 2013; Setren et al., 2021). A study conducted by Bell (2015) aimed to reveal the effect of the FCM on the learning process in high school physics classroom, students' learning levels, and students' attitudes towards the Physics lessons taught with the FCM. In the aforementioned study, the instruction designed according to the FCM was carried out in three classrooms, while the traditional teaching was done in another classroom. The study results revealed a difference in favor of the experimental groups in terms of the attitude variable, whereas no difference was found in terms of students' learning levels. In another study carried out by Guerrero et al. (2015), the effect of the FCM on university students' attitudes towards the math lesson and their achievement were explored. Similarly, this study revealed that while students' attitudes towards math differed significantly, the model did not have a significant effect in terms of student achievement. Also, Overmyer (2014) examined whether the FCM or the traditional model had an impact on university students' academic achievement in algebra. When the academic achievement scores of the students were compared, no significant difference was found between the groups. Furthermore, another study put forth that the FCM increased student participation and lesson satisfaction, but did not have a significant effect on academic achievement (Gross et al., 2015).

As it can be understood from the results in the literature, there are cases where the FCM can be effective on learning, but there are also cases where it is not effective. However, most of the studies determined that the FCM contributes to the development of positive student attitudes towards the lesson, and increases students' participation in the lessons and their satisfaction with the lessons (Aydın & Demirer, 2022; Karjanto & Acelajado, 2022). Based on the studies, it is recommended to create environments in which students play an active role in order for the FC model to be effective (Hurtubise et al., 2015; Koray, 2022). Teachers cannot make experiments in which students can be active in physics lessons, due to the issues such as lack of laboratories and insufficient class hours. In this study, the students in the experimental group were planned to do experiment actively, while the students in the control group were planned to conduct a demonstration experiment by the teacher. The purpose of this study is to determine the effects of the FCM application enriched with digital content for the 10th grade physics "Pressure and Buoyancy" subject on students' academic achievement, their physics lesson performance level, their problem-solving skills, and their attitudes towards the physics lesson. It is believed that the present study will contribute to the field since the literature on the application of the FCM in physics education is limited and the model's effectiveness in terms of certain variables was not sufficiently examined. One of the criticisms emphasized by researchers such as Clark (2013) and Coufal (2014) is that the studies on the FCM focus largely on higher education. This study aims to fill the gap in the literature because it is an experimental study carried out in physics classrooms and is conducted with high school students.

In the context of the purpose of the research, answers to the following sub-problems were sought.

1. Is there a significant difference between the academic achievement scores of the experimental group in which the FCM was applied and the control group who were taught according to the physics curriculum?

2. Is there a significant difference between the physics performance level scores of the students in the experimental group in which the FCM was applied and the control group who were taught according to the physics curriculum?

3. Is there a significant difference between the problem-solving skills scores of the students in the experimental group in which the FCM was applied and the control group who were taught according to the physics curriculum?

4. Is there a significant difference between the attitudes towards the physics lesson scores of the students in the experimental group in which the FCM was applied and the control group who were taught according to the physics curriculum?

METHOD

Since this study aimed to test the cause and effect relationship between variables, it was carried out using a quasi-experimental design with pretest-posttest control group in which the existing classes were formed by random assignment (Büyüköztürk et al., 2018; Çepni, 2014). Before the application, pretests were administered to both groups at the same time and measurements related to the dependent variable were taken. The experimental procedure based on the independent variable whose effect will be examined is applied in the experimental group, whereas applications in which the methods provided by the curriculum are used in the control group. The administered pretests were also applied as the posttest and the scores of the two groups were compared using appropriate techniques (Sönmez & Alacapınar, 2011). In the present study, the effects of the FCM applications on the dependent variables of "Academic Achievement", "Physics Performance Level", "Problem-Solving Skills" and "Attitudes" were examined. For this purpose, experimental and control groups were formed, and the FCM applications were used in the experimental groups, and methods appropriate for the 10th Grade Physics Curriculum, published on July 17th,2017 by the Ministry of National Education Board of Education, were used in the control groups. The standard notation of the study design is presented in Table 1

Table 1. *Standard Notation of the Study Design*

Group	*Measurement I*	*Procedure*	*Measurement II*
EG	$MCAAT_1$ $PPLT_1$ $LTGT_1$ $PLAS_1$	X_1	$MCAAT_2$ $PPLT_2$ $LTGT_2$ $PLAS_2$
CG	$MCAAT_1$ $PPLT_1$ $LTGT_1$ $PLAS_1$ (Dependent variables)	X_2 (Independent variables)	$MCAAT_2$ $PPLT_2$ $LTGT_2$ $PLAS_2$ (Dependent variables)

Symbols used in Table 1. are as follows:

EG: Experimental group in which the FCM was applied

CG: The control group who are taught with methods according to the physics curriculum

X1: FCM applications
X2: Methods appropriate for the physics curriculum
MCAAT: Multiple Choice Academic Achievement Test
PPLT: Physics Performance Level Test
LTGT: Logical Thinking Group Test (for determining problem-solving skills)
PLAS: Physics Lesson Attitude Scale

STUDY GROUPS

The present study was carried out with 10th grade students from a public high school in the Ereğli district of Zonguldak in the 2017-2018 academic year. Four classrooms were included in the study, two of them were randomly assigned as the experimental group, and the other two were randomly assigned as the control group. The experimental group consisted of 59 students, 34 females and 25 males, and the control group had 62 students, 37 females and 25 males. While the FCM was applied to the experimental group, the control group was taught with the methods provided by the standard physics curriculum. The duration of the lessons was equal in both groups, and it was assumed that the groups were not affected by each other in any way. No additional application was done.

PROCEDURE

In determining the equivalence of classes, students' physics lesson grade averages and year-end grade averages in 2016-2017 academic year were taken into consideration. By examining the literature in the field of physics education, "Pressure and Buoyancy", one of the 10th grade physics lesson subjects that students have the most difficulty with, was chosen as the unit to be taught (Goszewski et al., 2013; Loverude et al., 2003). The lesson plans and the instruction process of the experimental group covering all the learning outcomes were developed by the researchers based on the FCM. On the other hand, for the control group, the lesson plans were prepared based on the 10th grade physics curriculum. A website was built for the theoretical transfer of the subjects that will take place outside the classroom. The videos in which the lectures were recorded were prepared by the physics teacher of the study groups - the same person is the researcher in this study. The reason why the preparation and recording of the videos in which the theoretical explanations were given was done by the physics teacher was to provide the control groups with information from the same source and to act in accordance with the nature of the FCM and experimental research. For this study, which aimed to examine the effect of using the FCM in physics education on the learning products, four different lesson plans covering the four learning outcomes of the "Pressure and Buoyancy Force" subject were prepared. In the first stage, for each lesson plan, lecture videos related to the learning outcome were uploaded to the website and necessary warnings and controls were made for the students to study. In the second stage, a short quiz about the videos watched in the classroom was administered, parts that could not be understood were repeated and the questions of the students were answered. In the third stage, the students were divided into groups of four in the laboratory, the activities prepared beforehand were done and each group wrote an activity report. In the fourth stage, students completed the achievement, comprehension, and homework tests in the classroom under the guidance of the teacher. The first lesson plan was designed to take six hours and the other three lesson plans for three hours each. A total of 15 periods (five weeks) were allocated for the implementation of the four lesson plans. Below are the works carried out at each stage along with the visuals.

WORKS DONE IN THE EXPERIMENTAL GROUPS

In the experimental groups, lesson plans were prepared for each outcome in order to realize the four outcomes, and the practices were carried out as follows, respectively.

WORKS DONE RELATED TO LESSON PLANS

The first learning outcome of the "Pressure and Buoyancy" unit is "The student explains the concept of pressure in solids and stagnant liquids. The student analyzes the factors affecting pressure." In order to achieve this outcome, a lesson plan covering 240 minutes (six periods) was prepared. As required by the FCM model, first the experimental group students were given access to the site installed on the Google site platform, then theoretical content about the outcome was uploaded and shared for students to watch. The theoretical contents were prepared by the researcher, who is also the physics teacher of the students, and the explanations were given using his own voice and the drawings he made. The reason for this was to carry the theoretical information transmission that students were accustomed to the online environment with all its aspects. In addition, an announcements tab was added to direct the students about their homework and to remind them which video they should watch at which time periods.

Figure 1. *View of the Developed Website*

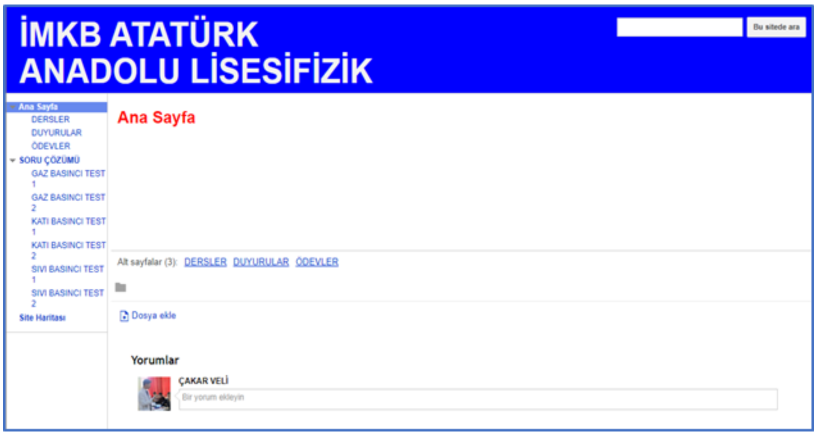
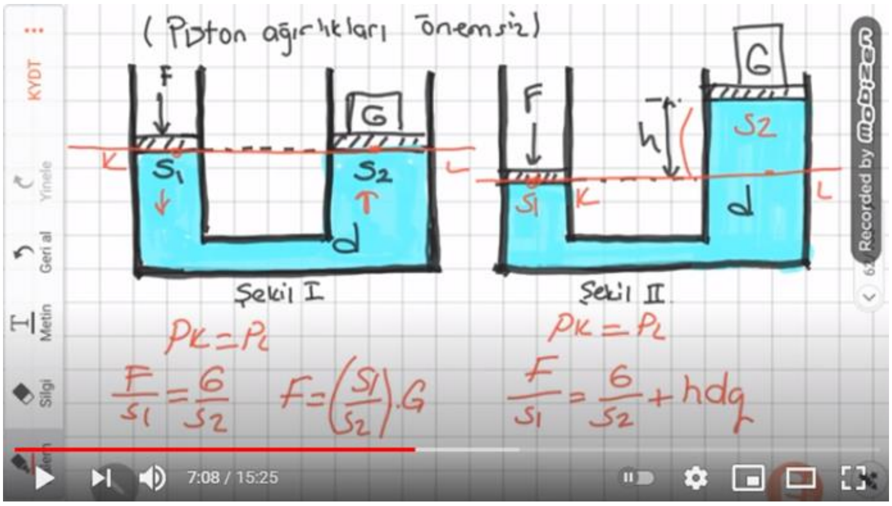


Figure 2. *An Example of the Theoretical Knowledge Explanations That the Students Watched on the Website*



A quiz consisting of three questions was made in order to determine whether the students could understand the subject by watching the theoretical information about the first learning outcome on the website, and the subject was reinforced by repeating the parts that the students did not understand. During the next 120 minutes (3 periods), the classroom was divided into groups of four, and four activities related to this learning outcome were carried out in the physics laboratory. After each activity, the groups were asked to fill out activity reports. In the last 40 minutes (1 period), the homework given to the students on the subject was done in the classroom under the guidance of the teacher. A second 120-minute lesson plan was prepared for the outcomes of "The student explains the concept of pressure in solids and stagnant liquids. The student analyzes the factors affecting pressure." and "The student discovers the relationship between the flow rate of fluids and fluid pressure." After making students watch the theoretical information about these learning outcomes, the gaps in students' knowledge were completed with a quiz. Two activities related to these learning outcomes were carried out in the laboratory, and homework related to the learning outcomes was done in the classroom again, accompanied by their teacher. In the study, a third lesson plan of 120 minutes was prepared for the learning outcome of "The student analyzes the effect of pressure on change of state." In order to achieve this outcome, after the students watched the theoretical information and the gaps in their knowledge were filled, two activities were carried out in the laboratory, and homework was completed in the classroom. Finally, a 120-minute fourth lesson plan was prepared for the learning outcome of "The student explains the buoyant force exerted by static fluids on objects." Again, in order to achieve this learning outcome, after the students watched the theoretical contents and the gaps in their knowledge were filled, two activities were carried out in the laboratory, and homework was completed in the classroom.

ACTIVITIES CARRIED OUT IN THE LABORATORY WITH THE EXPERIMENTAL GROUP STUDENTS

In the study, 10 activities were carried out in a laboratory environment by having all the students work in groups. The students carried out these activities with their physics teacher, who was also one of the researchers. After completing each activity, they wrote a group activity report. In the activity reports, the students were asked to discuss the results of the experiment regarding the status of the hypothesis proposed at the beginning of the activity. For example, in the third activity, the hypothesis "The liquid pressure at a point is directly proportional to the vertical distance of this point to the open surface of the liquid" was proposed and the students were asked to write down their ideas about the hypothesis by observing the inflation amounts of the balloons connected to the holes opened in different parts of the water-filled canister. They were also asked to interpret the activity results.

Figure 3. *Examples of Students' Work During the Activities*

WORKS DONE IN THE CONTROL GROUPS

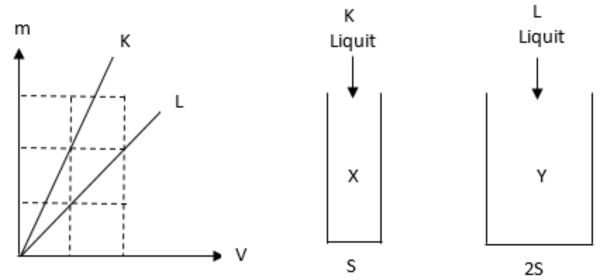
In the control groups, lesson plans were prepared by the researcher, the physics teacher of the study groups, in accordance with the yearly plan of the Ministry of National Education Board of Education. The lessons were taught using direct instruction, discussion, question, and answer techniques, and demonstration experiments were conducted for application. In the theoretical transmission of the subjects, the narration in the videos prepared for the experimental groups was followed. At the end of the lessons, homework was given to the control group students to reinforce the subjects, and they were given quizzes from time to time. Five activities were done in parallel with the textbook.

DATA COLLECTION TOOLS

Data collection tools used in the study are the "Multiple Choice Academic Achievement Test" (MSAAT), the "Physics Performance Level Test" (FPLT), the "Logical Thinking Group Test" (LTGT), and the "Physics Lesson Attitude Scale" (PLAS).

MSAAT: In order to determine the academic achievement levels of the students in the subject of "Pressure and Buoyancy", 54 multiple-choice questions based on the related learning outcomes were prepared after examining various textbooks, test books, and materials. The content validity of the test, the appropriateness of the questions to the learning outcomes, and the level of the students were ensured by obtaining expert opinions from 4 physics teachers whose professional experience ranged from 10 to 25 years. Based on the expert opinions, 14 questions were removed because they were not appropriate to students' level, were not clear enough, and were measuring the same outcome. Thus, the number of questions was reduced to 40. The item analysis of this test was conducted by administering the test to 98 11th grade public school students who had knowledge about the subject. The coefficient of internal consistency Cronbach's alpha was found to be .78. The test was administered as a pretest and posttest and the duration of the exam was determined as 40 minutes. Each correct answer in the test was scored with a score of 2.5, each wrong answer or question left blank with a score of "0". Thus, the possible test scores range from 0 to 100.

MSAAT Sample Question



Equal volumes of K and L liquids seen in Figure are taken and placed in X and Y containers with base sections of S and 2S.

Accordingly, what is the Px/Py ratio of the liquid pressures in the X and Y containers?

A) 2 B) 3 C) 4 D) 5 E) 6

FPLT: In order to determine students' physics performance levels, four basic questions were prepared based on the learning outcomes of the "Pressure and Buoyancy" subject. The questions were prepared by examining the science questions asked in the PISA exams, and each of the questions consists of three sub-questions. PISA is a research conducted to determine the science and math literacy and reading skills levels of 15-year-old students in today's information society (Anıl et al., 2015). One of the sub-questions for each basic question was multiple-choice, one was "true-false" and the other was open-ended. Multiple-choice questions were assessed as "5", true-false questions as "10", and open-ended questions as "10" points. In order to determine the appropriateness of the questions to students' levels and the learning outcomes, expert opinions were taken from 4 physics teachers whose professional experience ranged from 10 to 25 years and one academician. The highest score that students can get from the exam is "100" and the lowest score is "0". The duration of the exam was determined as 40 minutes.

FPLT Sample Question

A small iron nail sinks in water, but large ships made of iron do not sink in water. The state of an object sinking, floating, or suspended in a liquid is related to the density of the object and the liquid.

Objects with a density equal to that of the liquid remain in equilibrium at any point so that all of them remain in the liquid, while objects with a density greater than the liquid sink in the liquid and objects with a density less than the liquid floats.

I- Which of the following is the reason for large air tanks built in the lower sections of the ships?

A- To increase the sinking volume of the ship

B- To make the ship move fast

C- To take shelter in these air tanks in case the ship sinks

D- To reduce the iron ratio and increase the air ratio in order to ensure that the total density of the ship is smaller than the liquid.

E- To keep the ship level

II- In a container filled with liquid, an apple stays in balance at a depth of 10 cm from the liquid surface and lemon at a depth of 20 cm from the liquid surface without touching the bottom of the container. Therefore, the density of lemon is greater than the density of apple

TRUE (…) FALSE (…)

II- Ali throws his plastic toy into the water, then heats the water. He observes that as the temperature of the water increases, the toy sinks more into the water. Explain the reason for this event, taking into account the change in the density of the water and the toy with temperature.

LTGT: Originally developed by Roadranga, Yeany, and Padilla in 1982, the 21-item test was formed by selecting items with high validity and reliability from tests that measure students' different reasoning abilities (Ankney & Joyce, 1974; Burney, 1974; Lawson, 1978; Longeol, 1968; as cited in Korkmaz, 2002). The LTGT was translated into Turkish in 1989, first administered to 192 university students, then to 1298 middle and high school students. The validity and reliability studies were also conducted. The alpha reliability coefficient was found to be 0.78. Korkmaz (2002) administered the test to 7th grade students to measure their problem-solving skills. The results revealed that the test could be used to measure the logical thinking and problem-solving skills of middle school students in Turkey. In the present study, the LTGT was used to measure students' problem-solving skills. The test consists of 18 multiple-choice questions and three open-ended questions. In the first 18 questions of the test, the student who answered the question correctly and provided an acceptable reason for his/her answer was given a "1" point, and the student who answered the question or the reason wrong was given a "0". The correct answer to the last three open-ended questions was scored as "1" and the wrong answer were scored as "0". The duration of the exam was determined as 40 minutes.

PLAS: Developed by Kocakülah and Kocakülah (2006), the PLAS was used to examine the effect of the application of the FCM in physics lessons on the students' attitudes towards the physics lesson. The five-point Likert type scale was labeled as "totally agree, agree, undecided, disagree, and strongly disagree". There are 15 positive and 15 negative items on the scale. "I would like to learn more about physics subjects" is a sample from the positive items, and "The subjects taught in physics class bore me" is a sample from the negative items. The reliability coefficient of the scale was calculated as 0.96 for the pretests and 0.97 for the posttests for this study. The administration time was determined as 20 minutes. The scale was administered to the experimental and control groups as a pretest and posttest.

DATA ANALYSIS

Before analyzing the data collected in the study, the assumption of normality was tested. The experimental and control groups' pretest and posttest scores met the assumptions of normality for all the variables. Shapiro-Wilk test was applied in accordance with the number of participants (Razali & Wah, 2011). The p values of these tests calculated using the Shapiro-Wilks analysis were found to be greater than .05. Thus, it can be said that the assumption of normality was met. In this context, in order to test whether there was a significant difference between the variables of academic achievement, physics performance level, problem-solving skills, and attitude towards the lesson between the experimental and control groups, the collected data were analyzed using the t-test for independent groups in the SPSS program. In the independent samples t-test analysis, calculations were made on the difference scores between the posttest and pretest scores of these four variables. In order to test whether there was a difference between the pretest and posttest scores of the experimental and control groups, dependent samples t-test analysis was performed. For interpretation, the significance level for the hypothesis tests was set to 0.05.

FINDINGS

In this section, the findings of the sub-problems obtained as a result of the application are included, and the obtained data are explained with tables. Findings, interpretations and tables are arranged in order of research sub-problems.

1. Is there a significant difference between the academic achievement scores of the experimental group in which the FCM was applied and that of the control group who were taught according to the physics curriculum?

The independent samples t-test analysis results for the first sub-problem are given in Table 2.

Table 2. *Independent Samples t-Test Analysis Results of the Experimental and Control Groups According to the Academic Achievement Variable*

Group	*N*	$\bar{x}$	*S*	*sd*	*t*	*p*
Experimental	59	20.99	7.66	119	3.452	.001
Control	62	15.37	10.02			

$p<.01$

Table 2 shows that there was a significant difference between the academic achievement scores of the experimental and control groups ($t(119)=3.452$, $p<.01$, $\eta^2=0.09$). The academic achievement scores of the experimental group ($\bar{x}=20.99$) were higher than that of the control group ($\bar{x}=15.37$). According to this result, in terms of academic achievement variable, the FCM led to a significant difference in favor of the experimental group.

2. Is there a significant difference between the physics performance level scores of the students in the experimental group in which the FCM was applied and that of the control group who were taught according to the physics curriculum?

The independent samples t-test analysis results for the second sub-problem are given in Table 3.

Table 3. *Independent Samples t-test Analysis Results of the Experimental and Control Groups According to the Physics Performance Variable*

Group	*N*	$\bar{x}$	*S*	*sd*	*t*	*p*
Experimental	59	20.66	10.63	119	4.168	.000
Control	62	12.59	10.63			

$p<.01$

Table 3 shows that there was a significant difference between the physics performance level scores of the experimental and control groups. ($t(119)=4.168$, $p<.01$, $\eta^2=0,13$). Experimental group physics performance level scores ($\bar{x}=20.66$) were higher than the control group scores ($\bar{x}=12.59$). According to this result, in terms of the physics performance variable, the FCM led to a significant difference in favor of the experimental group.

3. Is there a significant difference between the problem-solving skills scores of the students in the experimental group in which the FCM was applied and that of the control group who were taught according to the physics curriculum?

The independent samples t-test analysis results for the third sub-problem are given in Table 4.

Table 4. *Independent Samples t-Test Analysis Results of the Experimental and Control Groups According to the Problem-Solving Skills Variable*

Group	*N*	$\bar{x}$	*S*	*sd*	*t*	*p*
Experimental	59	3.42	2.71	119	1.055	.294
Control	62	2.83	3.33			

p>.05

Table 4 shows that no significant difference was found between the problem-solving skill scores of the experimental and control groups ($t(119)=1.055$, $p>.05$). Although the problem-solving skill scores of the experimental group ($\bar{x}=3.42$) were higher than that of the control group scores ($\bar{x}=2.83$), the difference was not significant.

4. Is there a significant difference between the attitudes towards the physics lesson scores of the students in the experimental group in which the FCM was applied and that of the control group who were taught according to the physics curriculum?

The independent samples t-test analysis results for the fourth sub-problem are given in Table 5.

Table 5. *Independent Samples t-Test Analysis Results of the Experimental and Control Groups According to the Attitudes Towards the Physics Lesson Variable*

Group	*N*	$\bar{x}$	*S*	*sd*	*t*	*p*
Experimental	59	6.27	16.81	119	2.427	.017
Control	62	-1.48	18.25			

p<.05

Table 5 shows that there was a significant difference between attitudes towards the physics lesson scores of the experimental and control groups ($t(119)=2.427$, $p<.05$, $\eta^2=.05$). The attitudes towards physics lesson scores of the experimental group ($\bar{x}=6.27$) were higher than that of the control group scores ($\bar{x}= -1.48$). According to this result, in terms of the attitudes towards the physics lesson variable, the FCM led to a significant difference in favor of the experimental group.

DISCUSSION AND CONCLUSION

According to the study findings, in terms of students' academic achievement levels, there was a significant difference between the experimental group, in which the FCM was used, and the control group, in which the curriculum-based teaching, was done in favor of the experimental group. Accordingly, it can be said that the FCM was effective in increasing students' academic achievement levels.

In the literature, there are many studies that concluded that the FCM increases academic achievement (Finkenberg & Trefzger, 2019; Ismail & Abdulla, 2019; Limueco & Prudente, 2018). In his study, Yestrebsky (2015) divided his students into four levels A, B, C, D according to their achievement level in chemistry, and determined that the applications of the FCM model increased academic achievement in groups A and B with high achievement levels. Another study conducted by Leo and Puzio (2016) concluded that the FCM was effective in increasing the academic achievement of 9th grade students in biology. Similarly, Yurtlu (2018) reported that the application of the FCM in science classes increased achievement. Also, Akgün (2015) obtained data showing that the FCM increased academic achievement in the Information Technologies and Software lesson. In the present study, it can be said that the academic achievement of the control group may have increased due to the successful implementation of the methods required by the Physics Curriculum. However, according to the achievement scores of both groups, the achievement level of the experimental group, in which the Flipped Model was used, was significantly higher than that of the control group. Accordingly, it can be stated that the FCM is more effective than the methods offered by the Physics Curriculum. The fact that the students did more activities in groups in the experimental group, and that they came ready to the class due to the theoretical knowledge they received before the activities can be shown among the reasons for the achievement difference between the two groups.

There was a significant difference between the physics performance level scores of the experimental group, in which the Flipped Model was used, and the control group, in which the methods offered by the Physics Curriculum were used. Accordingly, it can be said that the FCM was effective in increasing the physics performance levels of the students.

In the literature, many studies revealed that the FCM improves learning performance (Lai & Hwangs, 2016; Strelan et al., 2020; Tune et al., 2013; Weaver & Sturtevant, 2015). A study on engineering education by Baytiyeh and Naja (2017) concluded that the model deepened students' learning and improved their problem-solving and critical thinking skills. Another study on the Algebra lesson by Kadry and Hami (2014) put forth that the model increases the learning performance and recall levels. Bawang and Prudente (2018) concluded in their study that the FCM is effective in increasing students' performance in physics. In the present study, although the physics performance variable was related to academic achievement, it mostly focused on students' higher-order thinking skills such as analysis, synthesis, and evaluation. The fact that the students had the opportunity to practice more with various materials in the classroom environment with their theoretical knowledge ready may have affected their physics performances positively. In their study, Acar and Öğretmen (2012) revealed that as the time allocated to learning at school increased, students' science performance increased, and as the time allocated to learning at home increased, performance decreased. At this point, it is of great importance what kind of work students do at home and how they use their time during the learning stage. The fact that the theoretical contents required by the FCM and the instructional applications changed places in the present study increased students' physics performance during the applications in school.

No significant difference was found between the problem-solving skill scores of the experimental group, in which the FCM was applied, and the control group, in which the curriculum-based instruction was used. In this context, one possible explanation to this finding is that the outcomes of the program were meticulously fulfilled by the teacher in the control group, where lessons were taught in accordance with the Physics curriculum. In addition, the FCM has been limited to the subject of "pressure and buoyancy" within the scope of the research. Considering a skill that requires comprehensive thinking processes such as problem-solving skills, it can be said that the application time is insufficient for the development of this skill. In a study conducted by Jensen et al., (2015), the FCM was not found to be effective for basic learning and deep learning. The results of the study, in which the FCM was used in the experimental group and the constructivist approach and active learning were used in the control group, show that the communication time that the students spend with their teachers at school is more effective on their learning than the time they spend at home. According to Odabaşı (1997) and Uşun (2000), it is emphasized that many factors such as individual differences, cooperation, cognitive skills, the teacher's role as a guide, learning by doing are necessary for the development of problem-solving skills.

Various studies in the literature revealed that the FCM improves problem-solving skills (Alias et al., 2020; Bawang & Prudente, 2018; Lin, 2019; Zappe et al., 2009). In the present study, unlike the studies in the literature, no difference was found between the problem-solving skills of the control group, who were taught in accordance with the curriculum, and the experimental group students. The examination of 2007, 2013, and 2017 science and physics curricula show that the curricula are centered around the research-examination strategy and that a perspective that will contribute to the development of students' problem-solving skills has gained importance. In this context, it can be said that the outcomes of the program were meticulously fulfilled in the present study by the teacher in the control group, where lessons were taught based on the physics curriculum. In addition, in the present study, the FCM was limited to the subject of "Pressure and Buoyancy". Considering a skill that requires comprehensive thinking processes such as problem-solving skills, it can be said that the application time was insufficient for the development of this skill. In a study conducted by Jensen et al. (2015), The FCM was not found to be effective for basic learning and deep learning. The results of the aforementioned study, which used the FCM with the experimental group students and used the constructivist approach and active learning with the control group students, showed that the communication time that the students spend with their teachers at school was more effective on their learning than the time they spend at home. According to Odabaşı (1997) and Uşun (2000), many factors such as individual differences, cooperation, cognitive skills, the teacher's role as a guide, learning by doing are necessary for the development of problem-solving skills.

Furthermore, in the present study, a significant difference was determined in favor of the experimental group, between the attitudes towards the physics lesson scores of the experimental group, in which the FCM was applied, and the control group, which followed the curriculum. In the literature, there are studies that revealed the FCM positively affected the attitude towards the lesson variable (Guerrero et al., 2015; Koray et al., 2018; Yurtlu, 2018). Bell (2015) concluded that the application of the FCM in the physics lesson positively affected students' attitudes towards the physics lesson. Bell (2015) put forth that the students in the group in which the FCM was applied had high attitude scores because they had the opportunity to work in cooperative groups, they used various materials in the context of the subjects, they had the chance to review their homework together with their teacher, and they had the opportunity to watch the theoretical lessons at the speed and frequency they wanted in a very comfortable environment. In their study, Steen-Utheim and Foldnes (2018) emphasized that the FCM increased the participation of Norwegian university students in math, thus increasing the learning experience of the students. In the same study, students also found the model effective in terms of feeling safe in the classroom, using the physical environment and communicating with their peers and teachers. The study conducted by Smallhorn (2017) emphasized that the FCM improved students' communication skills with each other and with their teachers and increased their participation in academic life, rather than increasing students' academic achievement.

The following recommendations can be made in line with the study results: It is important that the students who will use the FCM have individual learning and self-learning skills. By determining these skills in advance, choosing the extracurricular and in-class activities and materials to be prepared according to students' characteristics can facilitate the fulfillment of the expected goal. One of the problems faced by the practitioner in the FCM is related to the follow-up of responsibilities outside the classroom. Platforms where the practitioner can check whether or not students fulfilled their responsibilities regarding materials developed within the framework of out-of-class responsibilities in the FCM should be built and these platforms can send warning notices. In the present study, the FCM was applied to teach the "Pressure and Buoyancy" unit. The effects of using the FCM to teach the other units in the physics curriculum can be discussed and examined. In order to popularize the use of the FCM, the data obtained can be made available to teachers and students by creating a common platform and archive. New studies can be conducted to measure the effectiveness of the FCM on students' satisfaction. The lack of qualitative studies on the FCM is emphasized by researchers like Clark (2013) and Coufal (2014). In this context, researchers can design qualitative studies using the FCM.

LIMITATIONS and ETHICAL CONSIDERATIONS

The limitations of the present study are as follows: The study is limited to the subject of "Pressure and Buoyancy" and was applied over a five-week period. The students in the group in which the model was applied encountered this model for the first time.

Interpretation of the results in this study depends on the effects of threats to the internal validity of the study. In determining the equivalence of the classes, the year-end physics lesson achievement averages and year-end general achievement averages of the previous year were taken into consideration. If there is a maturation effect, both groups will be the same or similar to each other in the post-tests after the application. In addition, since there was no significant event related to the dependent variables of the study and the application process before the application, any past effects did not affect the study. There was no participant who left the study for any reason during the study.

Measuring tool impact, as a different type of threats, was checked in both applications using the same items, the order of application of the tools, and the same data collector. Another consideration related to instrument application, five weeks have been accepted as enough to prevent the testing effect. Access to the video links of the control group participants was not allowed in order to avoid interaction between the groups.

The study was approved by the decision of the Human Research Ethics Committee of Zonguldak Bülent Ecevit University, dated 31.01.2018 and issued 303.

AUTHOR CONTRIBUTION

-First author have made substantial contributions to conception and design, analysis and interpretation of data, and given final approval of the version to be published.
-The second author have made acquisition and analysis of data, and been involved in drafting the manuscript.
-The third author have been involved in drafting the manuscript and given final approval of the version to be published.

REFERENCES

Acar, T., & Öğretmen, T. (2012). Analysis of 2006 PISA science performance via multilevel statistical methods]. *Education and Science*, *37*(163), 178-189. http://egitimvebilim.ted.org.tr/index.php/EB/article/view/1040/346

Akgün, M. (2015). *The effect of flipped classroom on students' academic achievement and views.* [Master's Thesis, Fırat University]. Council of Higher Education Thesis Center, Turkey.

Alias, M., Iksan, Z. H., Karim, A. A., Nawawi, A. M. H. M., & Nawawi, S. R. M. (2020). A novel approach in problem-solving skills using flipped classroom technique. *Creative Education*, 11, 38-53. https://doi.org/10.4236/ce.2020.111003

AlJaser, A. M. (2017). Effectiveness of using flipped classroom strategy in academic achievement and self-efficacy among education students of Princess Nourah Bint Abdulrahman University. *English Language Teaching*, 10(4), 67-77. https://doi.org/10.5539/elt.v10n4p67

Anıl, D., Özer Özkan, Y., & Demir, E. (2015). PISA 2012 Araştırması Ulusal Nihai Rapor. [National Final Report of the PISA 2012 Survey]. *TR Ministry of National Education General Directorate of Assessment, Evaluation and Examination Services: Ankara.* Retrieved from http://pisa.meb.gov.tr/meb_iys_dosyalar/2020_12/23172540_pisa2012-ulusal-nihai-raporu.pdf

Arnold-Garza, S. (2014). The flipped classroom teaching model and its use for information literacy instruction. *Communications in information literacy*, *8*(1), 9. Retrieved from https://pdxscholar.library.pdx.edu/comminfolit/vol8/iss1/9/

Aydın, B., & Demirer, V. (2022). Are flipped classrooms less stressful and more successful? An experimental study on college students. *International Journal of Educational Technology in Higher Education*, *19*(1), 1-17. https://doi.org/10.1186/s41239-022-00360-8

Bawang, E. G., & Prudente, M. S. (2018). Students' understanding of physics concepts, attitude, engagement, and perceptions in a flipped classroom environment. *Advanced Science Letters*, *24*(11), 7947-7951. https://doi.org/10.1166/asl.2018.12463

Baytiyeh, H., & Naja, M. K. (2017). Students' perceptions of the flipped classroom model in an engineering course: a case study. *European Journal of Engineering Education*, *42*(6), 1048-1061. https://doi.org/10.1080/03043797.2016.1252905

Bell, M. R. (2015). *An investigation of the impact of a flipped classroom instructional approach on high school students' content knowledge and attitudes toward the learning environment.* [Master's Thesis, Brigham Young University]. https://scholarsarchive.byu.edu/etd/4444/

Bergmann J & Sams A (2012) *Flip your classroom: Reach every student in every class every day*. Eugene: ISTE: International Society for Technology in Education.

Butt, A. (2014). Student views on the use of a flipped classroom approach: Evidence from Australia. *Business Education & Accreditation*, *6*(1), 33-43. Retrieved from http://www.theibfr2.com/RePEc/ibf/beaccr/bea-v6n1-2014/BEA-V6N1-2014-4.pdf

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö. E., Karadeniz, Ş., & Demirel, F. (2018). *Eğitimde bilimsel araştırma yöntemleri. [Scientific research methods in education].* Pegem Academy.

Clark, K. R. (2013). *Examining the effects of the flipped model of instruction on student engagement and performance in the secondary mathematics classroom: An action research study.* [Doctoral Dissertation, Capella University]. https://www.une.edu/sites/default/files/Exam_Effects_Flipped_Model.pdf

Cole, J. E., & Kritzer, J. B. (2009). Strategies for success: Teaching an online course. *Rural Special Education Quarterly*, *28*(4), 36-40. https://doi.org/10.1177/8756870509028004

Coufal, K. (2014). *Flipped learning instructional model: perceptions of video delivery to support engagement in eighth grade math.* [Doctoral Dissertation, Lamar University-Beaumont]. https://www.proquest.com/pagepdf/1612629687?accountid=17396

Çepni, S. (2014). *Araştırma ve proje çalışmalarına giriş (7. Baskı) [Introduction to research and project studies (7th Edition)]*. Celepler Matbaacilik..

Driscoll, M. P. (1994). *Psychology of learning for instruction* (pp. 341–373). Allyn and Bacon.

Finkenberg, F., and Trefzger, T. (2019) Flipped classroom in secondary school physics education. *Journal of Physics: Conference Series*, 1286 012015. DOI 10.1088/1742-6596/1286/1/012015

Goszewski, M., Moyer, A., Bazan, Z., & Wagner, D. J. (2013, January). Exploring student difficulties with pressure in a fluid. In *Aip conference proceedings* (Vol. 1513, No. 1, pp. 154-157). American Institute of Physics. https://doi.org/10.1063/1.4789675

Gross, B., Marinari, M., Hoffman, M., DeSimone, K., & Burke, P. (2015). Flipped@ SBU: Student satisfaction and the college classroom. *Educational Research Quarterly*, *39*(2), 36-52. Retrieved from https://files.eric.ed.gov/fulltext/EJ1166718.pdf

Guerrero, S., Beal, M., Lamb, C., Sonderegger, D., & Baumgartel, D. (2015). Flipping undergraduate finite mathematics: Findings and implications. *Primus*, *25*(9-10), 814-832. https://doi.org/10.1080/10511970.2015.1046003

Howell, D. (2013). *Effects of an inverted instructional delivery model on achievement of ninth-grade physical science honors students.* [Doctoral Dissertation, Gardner-Webb University]. https://www.proquest.com/docview/1468701492?pq-origsite=gscholar&fromopenview=true

Hurtubise, L., Hall, E., Sheridan, L., & Han, H. (2015). The flipped classroom in medical education: engaging students to build competency. *Journal of Medical Education and Curricular Development*, 2, JMECD-S23895. https://doi.org/10.4137/JMECD.S23895

Ismail, S. S., & Abdulla, S. A. (2019). Virtual flipped classroom: New teaching model to grant the learners knowledge and motivation. *Journal of Technology and Science Educ*ation, *9*(2), 168-183. http://dx.doi.org/10.3926/jotse.478

Jensen, J. L., Kummer, T. A., & Godoy, P. D. D. M. (2015). Improvements from a flipped classroom may simply be the fruits of active learning. *CBE—Life Sciences Education*, 14 (1), ar5. https://doi.org/10.1187/cbe.14-08-0129

Kadry, Seifedine, & Abdelkhalak El Hami. (2014). Flipped classroom model in calculus II. *Education, 4*(4), 103-107. doi:10.5923/j.edu.20140404.04. Retrieved from *http://article.sapub.org/10.5923.j.edu.20140404.04.html*

Karjanto, N., & Acelajado, M. J. (2022). Sustainable learning, cognitive gains, and improved attitudes in College Algebra flipped classrooms. *Sustainability*, *14*(19), 12500. https://doi.org/10.3390/su141912500

Kazu, İ. Y., & Yalçın, C. K. (2022). A meta-analysis study on the effectiveness of flipped classroom learning on students' academic achievement. *E-International Journal of Educational Research*, *13*(1), 85-102. https://doi.org/10.19160/e-ijer.1033589

Kocakülah, M. S., & Kocakülah, A. (2006, April). Öğrencilerin yapılandırmacı öğrenme kuramına dayalı olarak işlenen fizik dersine yönelik tutumları. [Attitudes of students towards physics lesson taught based on constructivist learning theory]. *In 6th International Educational Technology Conference* (pp. 19-21).

Koray, A., Çakar, V. &Koray, Ö. (2018). High school students' opinions about using the flipped classroom ın physics teaching. The Turkish Online Journal of Educational Technology Special Issue for INTE-ITICAM-IDEC Vol.1, 619-624. Retrived from https://www.researchgate.net/publication/330384810_High_School_Students'_Opinions_About_Using_The_Flipped_Classroom_In_Physics_Teaching

Koray, A. (2022). A research on flipped classroom practice in modern physics teaching. *Karaelmas Journal of Educational Sciences*, *10*(2), 264-277. Retrieved from https://dergipark.org.tr/en/pub/kebd/issue/74811/1210566

Korkmaz, H. (2002). *The effects of project based learning on creative thinking ability, problem solving ability and level of academic risk taking in science education*. [Doctoral Dissertation, Hacettepe University]. Council of Higher Education Thesis Center, Turkey.

Lai, C.-L., & Hwang, G.-J. (2016). A self-regulated flipped classroom approach to improving students' learning performance in a mathematics course. *Computers & Education*, 100, 126–140. https://doi.org/10.1016/j.compedu.2016.05.006

Leo, J. & Puzio, K. (2016). Flipped instruction in a high school science classroom. *J. Sci. Educ. Technol., 25*, 775–781. https://doi.org/10.1007/s10956-016-9634-4

Limueco, J. M., & Prudente, M. S. (2018). Flipping classroom to improve physics teaching. *Advanced Science Letters*, 24(11), 8292-8296. https://doi.org/10.1166/asl.2018.12544

Lin, Y. T. (2019). Impacts of a flipped classroom with a smart learning diagnosis system on students' learning performance, perception, and problem solving ability in a software engineering course. *Computers in Human Behavior*, 95, 187-196. https://doi.org/10.1016/j.chb.2018.11.036

Long, T., Logan, J., & Waugh, M. (2016). Students' perceptions of the value of using videos as a pre-class learning experience in the flipped classroom. *TechTrends*, *60*(3), 245-252. https://doi.org/10.1007/s11528-016-0045-4

Love, B., Hodge, A., Grandgenett, N., & Swift, A. W. (2014). Student learning and perceptions in a flipped linear algebra course. *International Journal of Mathematical Education in Science and Technology*, *45*(3), 317-324. https://doi.org/10.1080/0020739X.2013.822582

Loverude, M. E., Kautz, C. H., & Heron, P. R. (2003). Helping students develop an understanding of Archimedes' principle. I. Research on student understanding. *American Journal of Physics*, *71*(11), 1178-1187. https://doi.org/10.1119/1.1607335

Odabaşı, F. (1997). Eğitimde sistem yaklaşımı ve eğitim teknolojisi. [System approach in education and educational technology]. *Education and Science*, *21*(106). Retrieved from http://213.14.10.181/index.php/EB/article/view/5948/2070

Osguthorpe, R. T., & Graham, C. R. (2003). Blended learning environments: Definitions and directions. *Quarterly review of distance education*, *4*(3), 227-33. Retrieved from https://www.learntechlib.org/p/97576/.

Overmyer, G. R. (2014). *The flipped classroom model for college algebra: Effects on student achievement* [Doctoral dissertation], Colorado State University. https://www.proquest.com/docview/1615100148?pq-origsite=gscholar&fromopenview=true

Razali, N. M., & Wah, Y. B. (2011). Power comparisons of Shapiro-wilk, Kolmogorov-smirnov, Lilliefors and Anderson-darling tests. *Journal of statistical modeling and analytics*, *2(*1), 21-33. Retrieved from http://www.de.ufpb.br/~ulisses/disciplinas/normality_tests_comparison.pdf

Roadrangka, V., Yeany, R.H., & Padilla, M.J. (1982). *GALT, group test of logical thinking*. Georgia: University of Georgia.

S. Khan, in TED Talks (2011), Retrieved from TED website: http://www.ted.com/talks/salman_khan_let_s_use_video_to_reinvent_education.html

Setren, E., Greenberg, K., Moore, O., & Yankovich, M. (2021). Effects of Flipped Classroom Instruction: Evidence from a Randomized Trial. *Education Finance and Policy*, *16*(3), 363-387. https://doi.org/10.1162/edfp_a_00314

Smallhorn, M. (2017). The flipped classroom: A learning model to increase student engagement not academic achievement. *Student Success*, *8*(2), 43-53. https://search.informit.org/doi/10.3316/informit.593366988343831

Sönmez, V., & Alacapınar, F. G. (2011). *Örneklendirilmis bilimsel araştırma yontemleri*. [Scientific research methods with examples]. Anı Yayıncılık.

Steen-Utheim, A. T., & Foldnes, N. (2018). A qualitative investigation of student engagement in a flipped classroom. *Teaching in Higher Education*, *23*(3), 307-324. https://doi.org/10.1080/13562517.2017.1379481

Strelan, P., Osborn, A., & Palmer, E. (2020). The flipped classroom: A meta-analysis of effects on student performance across disciplines and education levels. *Educational Research Review*, 30, 100314. https://doi.org/10.1016/j.edurev.2020.100314

Tune J.D., Sturek M. and Basile D.P. (2013) Flipped classroom model improves graduate student performance in cardiovascular, respiratory, and renal physiology. *Adv Physiol Educ*. *37* (4), 316–20. https://doi.org/10.1152/advan.00091.2013

Uşun, S. (2000). Özel öğretim teknolojileri ve materyal geliştirme. [Special instructional technologies and material development]. PegemA Pub.

Weaver, G. C., & Sturtevant, H. G. (2015). Design, implementation, and evaluation of a flipped format general chemistry course. *Journal of Chemical Education*, *92*(9), 1437-1448. https://doi.org/10.1021/acs.jchemed.5b00316

Wiginton, B. L. (2013). *Flipped instruction: An investigation into the effect of learning environment on student self-efficacy, learning style, and academic achievement in an algebra I classroom.* [Unpublished doctoral dissertation]. University of Alabama, Tuscaloosa, AL. https://ir.ua.edu/bitstream/handle/123456789/1881/file_1.pdf?sequence=1&isAllowed=y

Yestrebsky, C. L. (2015). Flipping the classroom in a large chemistry class-research university environment. *Procedia-Social and Behavioral Sciences*, 191, 1113-1118. https://doi.org/10.1016/j.sbspro.2015.04.370

Yurtlu, S. (2018). *Effect of the flipped classroom model on students' achievement and views in science education*. [Master's thesis, Muş Alparslan University]. Council of Higher Education Thesis Center, Turkey.

Zappe, S., Leicht, R., Messner, J., Litzinger, T., & Lee, H. W. (2009, June). "Flipping" the classroom to explore active learning in a large undergraduate course. *In 2009 Annual Conference & Exposition* (pp. 14-1385). Retrieved from https://peer.asee.org/4545