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Flipped Classroom adapted to the ARCS Model of Motivation and applied to a Physics Course

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This study aims to determine the effect on the achievement, motivation and self-sufficiency of students of the flipped classroom approach adapted to Keller's ARCS (Attention, Relevance, Confidence and Satisfaction) motivation model and applied to a physics course. The study involved 66 students divided into two classes of a physics course. The first class used the traditional lecture format while the flipped classroom model was used in the second. The research data were obtained via the physics concept test, motivation questionnaire, physics self-sufficiency scale and semi-structured interviews. It was found that the experimental group students were achieve more than the students in the control group. An increase in motivation and self-sufficiency of the students in the experimental group was identified as well. Thereafter, semi-structured interviews were carried out with students of the experimental group. It was found that they had positive opinions regarding the flipped classroom approach.

Keywords: active learning, ARCS motivation model, flipped classroom, physics education

INTRODUCTION

Studies regarding how to teach physics always attract the attention of educators (Serway and Kirkpatrick, 1988). Recent research shows that traditional teaching methods and techniques in physics courses have negative effects (Baş, 2010; Schaal, 2010). In traditional approaches to teaching physics (Covill, 2011), in which teachers are active and students are passive and are not responsible for their own learning, students simply listen and take notes (Brunsell and Horejsi, 2013). Students educated in such a way are likely to be failed individuals loaded with information based on memorisation rather than creative individuals that can question and produce solutions by tackling problems (Cano, Ruiz and Garcia, 2013). This also affects the motivation and self-sufficiency of students negatively (Sekercioglu, 2011; Acar, Türkmen and Bilgin, 2015). However, anxiety levels are

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lower for students that are highly self-sufficient since they are more determined in solving difficult problems and therefore are more achievement (Gülten and Soytürk, 2013). This is why it is extremely important to take self-sufficiency into consideration while regulating education-training activities to make students achieve more in physics courses (Kocakaya and Gönen, 2010).

Furthermore, in physics courses taught with a traditional approach, students do not realise the relationship between the subject and real life events (Baran and Maskan, 2010). If students learn a concept in active learning conditions by associating it with the real world, their learning is more effective and consistent (Yam, 2005). In active learning conditions, teachers simply guide and prepare class conditions in which effective learning approaches are used. Students in active learning participate in learning actively in cognitive, emotional, social and physical ways, and classify knowledge, examine by forming hypotheses and make connections with previous learning (Açıkgöz, 2002; Tekerek, Tekerek and Ercan, 2012; Demirci, 2015).

Educators that understand the importance of active learning, develope new strategies to activate students in the learning process (Findlay-Thompson and Mombourquette, 2014). In recent years the most popular teaching model that is based on active learning is the flipped classroom approach (Chen et al., 2014; Bergmann and Sams, 2014). The flipped classroom, or inverted classroom, is a special type of blended learning (Strayer, 2012). In this new approach, students watch lecture videos related to a subject and then prepare questions addressing issues that they do not understand (Fulton, 2012; Hung, 2014; Kapoun and Milkova, 2014). In the class, students take part in creative activities such as problem solving (alone or in groups), discussions and group work (Formica, Easley and Spraker, 2010). Tucker (2012) argues that the lecture videos do not need to be prepared by academics, but can easily be downloaded from Internet sites such as Khan Academy, YouTube or Ted. Using a flipped classroom approach does not change the pedagogic concept; instead, it transforms the passive listening period of students into active participation in the lesson (Nolan and Washington, 2013). According to Tucker (2012), the most important benefit of the flipped classroom approach is its support for team working and discussions within the classroom. The advantages for students that Fulton (2012) highlighted include being able to watch videos whenever and wherever they want, being provided learning opportunities at their own speed, encouraging them to think within or out of class (Kellinger, 2012) and being available for use with various teaching strategies (Love, Hodge, Grandgenett and Swift, 2013). This new approach increases the interaction between teacher and student by decreasing the amount of time the teacher spends on lecturing and revision (Seamen and Gaines, 2013). Therefore, teachers can spend more time on fulfilling the learning and emotional demands of students (Goodwin and Mille, 2013).

In order to make the flipped classroom approach effective, suitable teaching strategies should be used (Marlowe, 2012). The ARCS motivation model (Hardre,

State of the literature

- Flipped classroom is an active, student-centered approach that was formed to increase the quality of period within class. This approach has attracted particular attention of educators and researchers in different disciplines recently.
- Studies show that flipping is an effective teaching technique which can improve student performance.
- Studies on the flipped classroom reported that students engage in active learning and peer learning in class leads to deeper understanding of concepts than traditional model of classroom.

Contribution of this paper to the literature

- This study may have contributed to the literature since there are few studies available regarding the flipped classroom approach adapted to the ARCS motivation model on physics courses at universities.
- There are just few studies done physics course at university level.
- The aim of the study is attract attention to flipped classroom potential in education field and make it recognize more by educators and researchers.

2005), developed by Keller (1987), is quite important in increasing the effectiveness of teaching conditions and is the only motivation model. Since the ARCS teaching model is a student-centred teaching model, intensive student-student and student-teacher communication, which is the basis of active learning, is required. The ARCS motivation model consists of four basic dimensions, namely **A**ttention, **R**elevence, **C**onfidence and **S**atisfaction. In the literature, although there are many different studies regarding the ARCS motivation model and flipped learning, few studies have investigated them together. Although there are limited studies regarding the flipped classroom approach in mathematics, English, biology, engineering and computer science (Findlay-Thompson and Mombourquette, 2014; Bishop and Verleger, 2013; Ferreri and O'Connor, 2013; Kay and Kletskin, 2012; Marlowe, 2012), a few studies have been done in physics at university level (Winter 2013; Bates and Galloway, 2012; Deslauriers, Schelew and Wieman, 2011). Physics course grades of students in education faculties indicate that achievement rates in are low. Given this, the questions below were asked in order to determine the effect of the flipped classroom approach adapted to the ARCS motivation model in terms of the academic achievement, motivation and self-sufficiency of students in a lesson such as physics which students have difficulty understanding:

1. Did the applied method differentiate the achievement in understanding physics between the control and experimental group?
2. Did any change occur in self-sufficiency of students educated with the flipped learning approach adapted to the ARCS model?
3. Did any change occur in the motivations of students educated with the flipped learning approach adapted to ARCS model?
4. What are the opinions of students regarding the flipped learning approach adapted to the ARCS model?

LITERATURE REVIEW

Some studies regarding the flipped classroom approach found in the literature are discussed below.

Chen et al. (2014), developed a model named the "Holistic Flipped Classroom" in order to address the gap in research on model designs regarding flipped classroom approaches. The model was applied in a university in Taiwan with 32 students taking a computer networking and internet course for 18 weeks. At the end of the research it was found that the applied model was effective and increased the participation of students. Moreover, it was stated that some students were pleased with the model, while others continued their previous passive habits.

Hung (2014) used the flipped classroom approach in English language teaching lectures and concluded that it had positive effects on academic achievement, attitudes and lesson participation levels of students.

Roach (2014) suggested that there was an important increase in the active participation of students and got positive reactions from students after applying a flipped classroom approach.

Winter (2013) examined the efficiency of the flipped classroom approach compared to the traditional model. In this study, carried out on 124 students taking the General Physics-1 course at Mississippi State University, an experimental group of students were taught with the flipped classroom approach while a traditional approach was employed for the control group. Before beginning, the same pre-test was used to measure the physics knowledge of both groups and found that the scores of the groups were statistically the same. At the end of research, there was not any statistical difference between the post-test and pre-test of each group.

Love et al. (2013) compared the efficiency of a flipped classroom approach (27 students) and a traditional approach (28 students) in a linear algebra course. It was found that in the flipped classroom class there was an increase in the performance of students while no change was perceived in the performance of students in the traditional class. In the questionnaire done in order to determine the attitudes of students towards the flipped classroom approach, it was observed that 74% of students had a positive attitude and more than 74% found it entertaining.

Deslauriers, Schelew and Wieman (2011) compared the effects of traditional and flipped classroom approaches on physics classes. A comparison was done under controlled circumstances between two student groups taking a physics course at bachelor degree level (N = 267 and N = 271). It was found that the participation and achievement of students in the flipped classroom approach class doubled compared to the students in the traditional approach class.

METHODOLOGY

This study is a mixed study in which quantative and qualitative methods were used. The quantitative data of this research were obtained from "physics concept tests", "physics self-sufficiency belief scales" and "physics course motivation questionnaires". On the other hand, qualitative data were obtained from "semi-structured interviews".

Participants

A total of 66 university students (30 control, 36 experimental) in their second year at the Computer and Instructional Technologies Teaching Department taking physics courses were the participants of this study. The control group consisted of 11 female and 19 male students, whereas the experimental group consisted of 14 female and 22 male students.

Research design

In this study, pre-test and post-test experimental designs with control groups and mixed design that consisted of qualitative data were used. The research design is given in Table 1.

Before beginning the experiment, only the "physics concept test" was applied to the control group whereas for the experimental group physics course the "physics concept test", "physics self-sufficiency belief scale" and "physics motivation questionnaire" were used. In the control group the lessons were conducted with a traditional approach and in the experimental group lessons were conducted with a flipped classroom approach adapted to the ARCS model. At the end of the experimental processes, the "physics concept test" was used post-test. In the experimental group, the "physics concept test", "physics self-sufficiency belief scale" and "physics motivation questionnaire" were used. Moreover, at the end of the experimental processes, semi-structured interviews were conducted with 10 students.

Procedure

This study was carried out over an 8-week period in the 2014-2015 academic year. "Movement on Earth" and "Work-Energy" units were taught to both groups of students. Since students always confuse the concepts in the "Work-Energy" unit,

Table 1. Research design

Groups	Pre Test	Application	Post test
Experimental Group	Physics Concept Test Self-sufficiency belief scale Motivation questionnaire	Flipped Classroom	Physics Concept Test Self-sufficiency belief scale Motivation questionnaire Semi-structured interview
Control Group	Physics concept test	Traditional Teaching	Physics concept test

they are unable to associate them with the real world. However, the subjects in the "Movement on Earth" unit are closely related with daily life and were specially chosen for this reason. The courses were given to experimental and control groups by the researcher.

Before commencing, the experimental group was informed about the flipped classroom approach. At the beginning of the period, the researchers prepared activities, video lectures and simulations suitable for the ARCS model for each subject in the "Movement on Earth" and "Work-Energy" units. Video lectures were produced using Sketchbook Pro software on a Wacom pen tablet. They were recorded with Camtasia Studio 8 screen capture software. The video lectures were consistently between 10-15 minutes in length to ensure reasonable viewing time for students as suggested by Bergmann and Sams (2012). Video lectures were delivered to the students via Moodle each week. Students were given up to three days to watch the video lecture. Table 2 shows the video lecture topics and the video length.

Each class lasted 55 minutes and took place once a week. To ensure that students were watching the video lectures online, quizzes were embedded into the video. While students were watching the video, the results were automatically scored and sent to the researcher in a spreadsheet. Camtasia Studio made it easy to embed quizzes into the videos. Furthermore, the participants were sent answer keys to check their answers. The instructor did not put aside time in class to solve the quiz questions since the concepts on which they were based were discussed in class. The researcher believes that the quizzes motivated students to watch the videos, as each quiz counted towards the course grade. Students who did not watch the video lecture did not receive points (See Figure 1).

As can be seen in Figure 2, this method consisted of two stages: before and during class.

Before Class: The student watches the video lecture at any time before the lesson,

Table 2. Video lecture topics and video length

Video Lecture Topics	Length (minute)
Vectors	10
One dimensional motion	15
Two dimensional motion	13
The concept of force	11
Newton's Laws of Motion	15
Work by a Constant Force	14
Work by Variable Force	12
Kinetic Energy and Work-Kinetic Energy Theorem	15

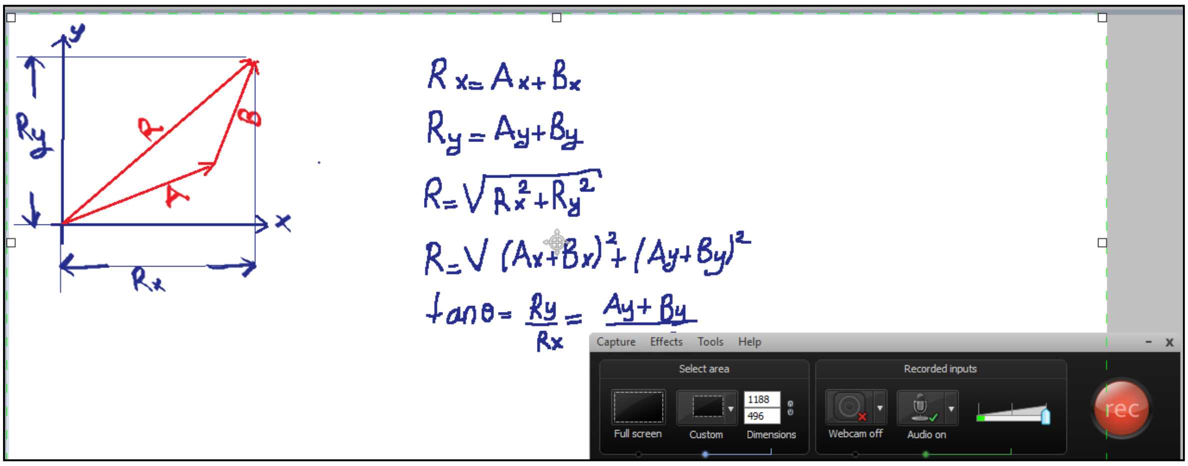

Figure 1. Sample screencasted with Camtasia software

takes notes and prepares questions about the subjects that he does not understand. While students were watching video lectures they answered embedded questions.

During Class: Activities within class are carried out according to the ARCS motivation model. The lesson begins with an event or news item from daily life in order to attract the attention of students (Attention). It is intended that students realise the relevance of physics in their own lives by associating physics concepts with prior-knowledge of students (Suitability). It is also intended that students develop self-confidence and a positive attitude for achievement by providing situations for experiencing what they have learnt (Confidence). It is intended that they feel a sense of satisfaction by being awarded with positive reinforcement (Satisfaction). In order to increase the motivation of students, simulations are employed. The students try to find solutions with their peers to the questions prepared after the video lecture. In addition, it is intended that students participate in lessons actively by taking part in discussions during lessons; mistakes during discussions are corrected during the lesson. In addition, self-sufficiency belief levels of students and consolidation of their knowledge are achieved by solving problems

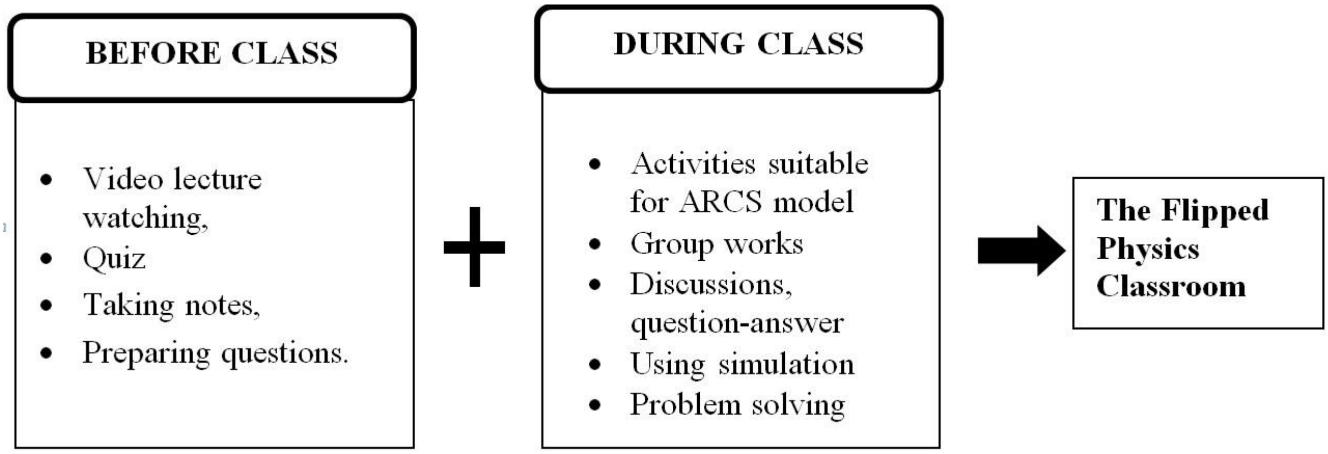

Figure 2. the flipped physics classroom adapted to the ARCS Motivation Model

Data collection and analysis

In the study, quantitative and qualitative data collection instruments were used together. A physics concept test, the self-sufficiency belief scale and a motivation questionnaire were used as a quantitative data collection tool. To collect qualitative data, semi-structured interviews were carried out. An attempt was made to increase the validity of measurements by using more than one measuring tool (triangulation) (McMillan and Schumacher, 2010). In the analysis of quantitative data using arithmetic means, standard deviation and t tests were use. In the analysis of qualitative data, frequency and coding techniques were used.

Physics concept test

In order to identify the effect of the Flipped Classroom approach on the academic achievement of students, a physics concept test consisting of 40 multiple choice questions was prepared by researchers after determining target behaviours of the "Movement on Earth" and "Work-Energy" units. After forming test questions, in order to make the analysis valid and reliable, the test was applied to 100 students from the study group that had been taught the "Movement on Earth" and "Work-Energy" units through a traditional approach. After this pilot implamantation, correct answers (p: item difficulty index) and cognizant and incognizant (r: item distinguishing index) were calculated. After applying item analysis, in order to examine internal consistency, Kuder Richardson-20, 21 (KR-20, 21) coefficients were used (Büyüköztürk, 2007). In studies conducted for research reliability, the coefficient is required to be at least 0.70 (Sencan, 2005). In total, 26 items whose item distinguishing index is over 0.30 and item difficulty index is between 0.40 and 0.76 were included in the main test form and the other 10 items from these criteria were removed from the test. Therefore, 26 test questions suitable for the required properties were chosen. In order to find internal consistency among these 30 items, KR-20 and KR-21 reliability coefficients were found to be 0.73 and 0.70, respectively. These values are important for the reliability of the test (Ozen, Gulacti and Kandemir, 2006).

The physics concept test was used as a pre-test to determine the readiness level of the control and experimental groups. It was also used as a post-test 8 weeks later for both groups to identify which one, if any, had greater knowledge of the physics topics covered.

Self sufficiency belief scale for the physics course

In order to measure the self-sufficiency level of students the "physics self sufficiency belief scale", developed by Tezer and Aşıksoy (2015), was used. The researchers calculated the Cronbach's Alpha coefficient of the scale to be 0.98. The scale consisted of 34 items formed using two sub-factors, "learning level dimension" and "solving of physics problems dimension". The physics self-sufficiency belief scale is a five point Likert type scale (5= completely agree, 1= completely disagree). The scale was used as both a pre-test and post-test for the experimental group during the study.

Physics course motivation questionnaire

In order to identify the effect of the applied teaching model on the motivation of the students, an SMQ (Science Motivation Questionnaire) developed by Glynn, Taasoobshirazi and Brickman (2009) and translated into Turkish by İlhan, Yıldırım and Yılmaz (2012) was used. It consisted of 22 items and was used as both a pre-test and post-test for the experimental group during the study. The reliability coefficient of the applied motivation questionnaire was calculated as .0890.

Semi structured interviews

In order to gather the opinions of the students of the physics course delivered via the flipped classroom approach adapted to the ARCS Motivation model, the researchers prepared a semi-structured interview form consisting of 8 open-ended questions. The form was presented to a panel of 8 academics, from the fields of physics (3) and educational sciences (5), and necessary corrections were made according to their suggestions. At the end of 8-week application, semi-structured interviews with 10 voluntary students from the experimental group were conducted. The interviews were recorded after obtaining permission from the students and transcripts of each interview were made.

For quantitative data, the "Coding done according to concepts taken from data" technique was used. Two researchers collected data separately and then made a comparison. Data obtained from the answers of students were coded separately and brought together in a framework of specific concepts. In the following stage, the frequencies of these codes were presented in tables. The identities of the 10 interviewed students were not disclosed and each was assigned a number (S1, S2, etc.).

RESULTS

In this section the findings of the data analysis are presented below under sub-titles in the framework of the research questions.

Effect of applied method on the achievement of the students

The physics concept test was used as a pre-test applied before beginning the course to identify the readiness levels of control and experimental groups. There should be a homogenous distribution in respect to academic knowledge between experimental and control groups. As can be seen in Table 3, the data obtained from the pre-test were applied to the independent t-test.

As can be seen in Table 3, there is not any significant difference between the achievement of the control and experimental groups (p>.001). This finding indicates that both groups of students have the same academic level of knowledge prior to commencing the experiment.

In order to ascertain if there is any significant difference between the scores of the experimental and control groups at the end of the study, the "physics concept test" was used as a post-test and for independent groups a t-test was used also.

As can be seen in Table 4, post-test achievement scores of control group students taught with traditional approaches were lower than those of the experimental group taught with a flipped classroom approach adapted to the ARCS Motivation model. Although there is an increase in both groups, the increase in the experimental group was statistically significant. According to this finding, it can be said that when teaching this particular physics course, the flipped classroom approach adapted to the ARCS motivation model has a more positive effect than the traditional approach.

Effect of the applied method on the physics self-sufficiency beliefs of students

In order to investigate the effect of each method on the physics self-sufficiency

Table 3. Independent group t-test results regarding pre-test scores of experimental and control groups

Groups	N	$\bar{X}$	S	sd	*t*	*p*
Experimental	36	46.11	9.61	1.60	0.414	0.255
Control	30	45.03	11.53	2.11		

Table 4. Independent groups t-test results regarding post-test scores of experimental and control groups

Groups	N	$\bar{X}$	S	sd	t	p
Experimental	36	74.63	11.69	1.949	3.676	0.000
Control	30	62.12	15.92	2.906		

Table 5. t-test results of pre-test and post-test points belonging to self-sufficiency scale sub-dimensions

Physics self-sufficiency scale sub-dimensions	Pre Test			Post test			*t*
	N	$\bar{X}$	sd	N	$\bar{X}$	sd	
Learning level	36	2.649	.826	36	4.183	.602	-8.471
Solving physics problems	36	2.384	.685	36	4.136	.558	-11.877

**p<0.001*

beliefs of students, the physics self-sufficiency scale was used as a pre-test and post-test. The scores obtained from this scale, formed from the learning level and physics problem-solving sub-dimensions, were graded for each sub-dimension. Furthermore, for comparison of pre-test and post-test, a paired t-test was used.

As can be seen in Table 5, for the "Learning level" sub-dimension in the physics self-sufficiency scale, it was observed that the difference between pre-test and post-test scores are statistically significant ($t(35)=-8.471$, $p<.001$). Moreover, there was a statistically significant increase after the study for self-sufficiency regarding the "Solving physics problems" sub-dimension ($t(35)=-8.471$, $p<.001$). This finding shows that a flipped classroom approach adapted to the ACRS motivation model has a positive effect on the physics self-sufficiency beliefs of students.

The item "I can determine the important points of physics subjects" had the greatest increase in average scores among items of the "learning level" sub-dimensions of the self-sufficiency scale, with its post-test average score increasing to($\bar{X}$)=4.47 from its pre-test average score of $\bar{X}$=2.61. The pre-test average score of the item "I can find clues for physics problems" was $\bar{X}$=2.47, while the post-test average score was determined to be $\bar{X}$=4.17. The pre-test average score of the item "I can analyse the points in physics problems" was $\bar{X}$=2.44, while the post-test average score was determined to be $\bar{X}$=4.19. Finally, the pre-test average score of the item "My belief in solving a hard physics problem is complete" was $\bar{X}$=2.39, whereas the post-test average score was $\bar{X}$= 4.08.

Effect of applied method on the motivation of students

The results of the questionnaire conducted before beginning the courses to determine the effect of the flipped classroom approach adapted to the ARCS motivation model on the motivation of students and the results of a paired t-test of this questionnaire carried out afterwards are presented in Table 6.

It was observed that there is a statistically significant increase in the motivation of students ($t(35)=-33.371$, $p<0.001$). This finding indicates that their motivations have increased for the flipped classroom approach adapted to the ARCS motivation model, maybe because the physics course was made engaging.

For the motivation questionnaire, the three following items showed the greatest increase. For the item "I like learning physics subjects", the pre-test average score was $\bar{X}$=1.58, whereas the post-test average score was $\bar{X}$=4.13. For the item "It is more important to learn Physics completely rather than taking a high mark", the pre-test average score was $\bar{X}$=1.61, while the post-test average score increased to $\bar{X}$=4.19. Similarly, for the item "I trust myself to be successful in Physics exams" the pre-test average score was $\bar{X}$=1.61, whereas the post-test average score was determined as $\bar{X}$= 4.05.

Opinions of students towards the Flipped classroom approach adapted to the ARCS motivation model

In order to obtain the opinions of the students towards the different approaches, 10 volunteers were interviewed. The findings from the interviews are tabulated below in Table 7.

Table 6. t-test results of average points in pre-test and post-test motivation questionnaires

Physics concept test	N	$\bar{X}$	sd	df	t	p
Pre-Test	36	2.452	.128	35	-33.371	0.000
Post-Test	36	3.767	.175			

Table 7. Opinions of students towards the flipped classroom approach adapted to the ARCS motivation model

Codes	Frequency (f)
Access from everywhere at any time	8
Provides repetition	10
Increase discussion within class	8
Increase attention to the course	8
Provide comprehensive learning	7
Should be used in other courses	8
Provides more effective learning than traditional approach	2

In the interviews, the students stated that they were pleased with having access to video lectures at any time and from anywhere, making it more convenient for them overall.

> (S1): "In this system the teacher shares the subjects in video form with us as we can reach them from any where and at any time. We use our course time more efficiently."
>
> (S7): "The most pleasant side of it is to watch physics course[s] at home in a relaxing environment while drinking coffee."

All students said that they can watch video lectures according to their own speed of learning, have the opportunity to watch the videos as often as they want and can learn the points that they did not understand by watching again.

> (S4): "If you do not understand you can rewind. Knowing that you can watch it over and over again decreases my stress."
>
> (S1): "... If you do not understand something in a difficult course such as physics at once, with this method you can make the teacher on the screen explain the subject as many times as you want."

The students stated that making preparations beforehand enables them to participate in lessons actively rather than listening passively. Therefore, the flipped classroom approach is more interesting.

> (S9): "Everybody is more active in courses than before. Even friends whose voice we did not hear before participate in the discussions."
>
> (S2): "Although I do not like physics, the discussions in the class attracted my attention. I participated unselfconciously and shared my ideas. This kind of thing happened to me for the first time in this lesson. Before that, I pretended that I was listening to the teacher."

Furthermore, most students said that they want the flipped classroom approach to be used in other courses. It is interesting that two students think that the lessons that are taught with a traditional approach are more effective.

> (S8): "The old method was better. We could ask questions immediately in lessons when the teacher was teaching. I do not like this method."
>
> (S5): "While the teacher was teaching, you had to listen to him. However, I do not want to dedicate time to this new method at home."

DISCUSSION

This study was carried out to examine the effects of the flipped classroom approach adapted to the ACRS motivation model in a physics course on academic achievement, self-sufficiency and motivation of students, and to determine the opinions of students towards flipped classroom approaches.

Before the implementation, the pre-physics concept test scores indicate that the knowledge levels of both groups were the same.

The post-test results indicate that students in the experimental group were achieve more than students in the control group. The reasons for the increase in achievement of the experimental group can be interpreted as the transmission of knowledge achieved via video lectures out of class as they were able to internalize knowledge according to their own learning speed and could repeat the course as many times as they wanted. Furthermore, data transmission was done by video lectures and course time was divided up for discussions and problem solving activities. The use of simulations was also thought to have had an effect on increasing achievement. Flipped classroom approaches that encourage students to gain cognitive skills such as knowledge acquisition before lessons, as well as focusing on higher-level cognitive skills such as application, analysis, synthesis and evaluation with the support of their friends and teachers during lessons, agree with the Bloom Taxonomy. In the literature, as observed in this study, it was found that the flipped classroom approach increases the academic ability of students (Hung, 2014; Kong, 2014; Schultz et al., 2014). However, the findings of a study by Frydenberg (2012) do not agree with the findings of this present study. Teaching Excel using a flipped classroom approach, he found no increase in the achievement of the students when compared with the traditional approach. In another study by Winter (2013) involving the flipped classroom approach in a physics course, again, no increase in the achievement of students was observed. In this study, the reasons for the increase in achievement is thought to be the positive adaptation of the ARCS motivation model to a flipped classroom situation and the use of supporting activities involving simulations.

The other result of this study is the significant increase in scores of sub-dimensions of the "learning level" and the "solving physics problems" of the physics self-sufficiency scale. This suggests that the flipped classroom approach adapted to the ACRS motivation model has a positive effect on the self-sufficiency of students. The increase in self-sufficiency of students taught with the flipped classroom approach may encourage them to be responsible for their own learning and participate in discussions in class. Moreover, it is thought that the online quizzes embedded into the video lectures had an important role in allowing them achieve a sense of achievement. Successful experiences (Schunk, 2004) are the most important way of increasing self-sufficiency levels, verifying this result. The results of this study also agree with those of studies done by Kenna (2014) and Enfield (2013).

The other important result of the study is the significant increase in motivation scores for the questionnaire given to the experimental group. It is thought that the flipped classroom approach has an effect on giving active learner roles to students and enabling them to participate in discussions in class. In addition, giving examples associated with daily life and using simulations are thought to increase motivation. The result of this study supports the idea that the motivation levels of students increase in active learning conditions as well as when associating subjects with daily life, increasing their interest in and motivation for a subject (Tekbıyık and Akdeniz, 2010).

Regarding the semi-structured interviews done with the experimental group, most of the students expressed positive opinions about the flipped classroom approach adapted to the ACRS motivation model. The students also stated that class given through this method is more effective and entertaining since they get knowledge about the lesson via video lecture. This highlights the case that learning physics in a course with a flipped classroom approach adapted to the ACRS motivation model has positive effects on students. However, there are students that also have negative opinions about this method. It is thought that these students may have a bias towards the flipped classroom approach. The results of this study are consistent with those of other studies regarding the flipped classroom approach (Baepler, Walker and Driessen, 2014; Chen et al., 2014; Enfield, 2013).

This study will contribute to the literature since there are few studies available regarding the flipped classroom approach adapted to the ARCS motivation model for physics courses at university.

LIMITATIONS

There are several methodological concerns with the present study. The first is that the study is limited to the teaching of the "Movement on Earth" and "Work-Energy" units. The other limitation is the consideration that lower numbers of students have a bias towards this method since it is new.

In the light of the research results, the suggestions below were presented.

For future research, educators in the field could be given theoretical and practical training and their opinions regarding the application of the flipped classroom approach adapted to the ARCS motivation model can be gauged. Furthermore, in order to increase the efficiency of the approach, using different learning strategies such as problem based learning and cooperative learning may be beneficial. In addition, with the exception of Moodle for video, access to extended online communities such as Youtube and Blackboard could be used. Lastly, it is suggested that this approach be used for different courses in the manner it was applied here to a physics course.

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