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To FLIP or not to FLIP: Comparative case study in higher education in Turkey

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ABSTRACT

The purpose of this study was (1) to investigate the effectiveness of the flipped-classroom approach, when coupled with problem-based learning and cooperative learning, compared to that of a traditional classroom; (2) to investigate the effects of watching videos and of doing homework on achievement in a physics course; and (3) to evaluate students’ perception of the use of the flipped-classroom format in a physics course. In this study, both qualitative and quantitative data were collected. A pre-test/post-test quasi-experimental method with a control group was used. The results showed that homework performance and the amount of video watched (preliminary work before class) were significantly more effective for student achievement in the flipped-classroom. Moreover, although students struggled to adapt to the new system at the beginning, students who know and feel responsible for their own learning can close the gap with more individual and group activities and can achieve higher grades.

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1. Introduction

This article reports a case study on using the flipped-classroom model to teach a physics course to second-year students in the Department of Computer Education and Instructional Technologies at the Faculty of Education at Uludağ University. It presents the results of a two-year study on a university-level physics course. A traditional class was used in one year, and a flipped-class was used in the other.

2. Background of the study

Department of Computer Education and Instructional Technologies (CEIT) was founded first at Middle East Technical University within the restructuring process of Turkish universities in 1998. The aim of these department is to train teachers who will teach computer-related courses in primary and secondary schools (Board of Higher Education, 1998).

In Turkey, to study at any university, students take two university entrance exams in two steps. The first one (Exam 1) measures basic skills gained in secondary school and high school, whereas the second one (Exam 2) evaluates high-level skills related to the fields studied in high school. High-school graduate students enter CEIT with Exam 1. However, the content of the physics course requires a higher level of skills in CEIT.

Students in CEIT Department have to complete courses in three general categories: subject-field courses, science and mathematics courses and teaching-formation courses. However, the distribution of these fields was not adequate. Although these students would become computer teachers, they had to take 30 h of science and mathematics courses in addition to 40 h of computer-related courses (Karal & Timuçin, 2010). In 2007, the curriculum of the CEIT was changed, and chemistry and biology courses were removed from the program. However, instead of removing physics courses, the hours of physics courses were decreased from four to three hours (Board of Higher Education, 2007).

Acat, Kilç, Girmen, and Anagün (2007) aimed to identify the levels of the necessity and applicability of the courses offered in the Department of CEIT based on the views of the fourth-year and graduated students. A questionnaire with four intervals including the 43 courses offered in CEIT was administered. It was found that Physics I and Physics II courses were ranked 39th and 40th in terms of the knowledge necessity level and applicability level. Restructuring the science and mathematics courses was suggested (Acat et al., 2007).

Today, as in most of the disciplines, there is a need to redesign the way physics is taught in higher education. Physics education...
still widely uses outdated methods to teach complicated concepts and problem solving (Lyons, 2004). Methods used in lecturing must be transformed from a traditional-classroom model to more applied, learner-centered classroom model. With this model, students are able to interact, analyze, interpret, evaluate, employ various problem-solving methods, and engage in concept development and active/engaged, socially constructed, discovery, hands-on and case-based learning (Becky, 2009; Sridevi, 2008). One of the problems educators face in a learner-centered classroom is that an educator needs free time for active, problem-based and individualized learning. This problem can be overcome using various approaches. One promising method is to change the order of learning process. Students can first learn the content outside the class before class time, and then, problem-based learning, discussions, cooperative learning, and active learning activities can be applied in class. The order of the learning process is inverted, or flipped, which is why this model is called the flipped-classroom model (Camel, 2011; Hamdan, McKnight, McKnight, & Arfstrom, 2013; The Center for Digital Education, 2012; Truss, 2011).

2.1. Flipped-classroom model

To increase the motivation of learners in physics courses and to enhance learning, computer technology—particularly Internet applications and multimedia properties—are used in teaching and learning processes. In the previous application of the flipped-classroom model, most students did study the concepts before class at home by reading text material and/or doing homework (Berrett, 2012), or online tutoring systems were used to teach concepts outside the class activities (Bates & Galloway, 2012; Strayer, 2012). Because of recent improvements in technology, web pages, interactive video properties and recorded videos are generally preferred to introduce content outside the classroom. Then, the classroom is used for active learning activities, such as discussion, problem solving, and group work. Students generally prefer these types of activities. As shown in the literature, students prefer to be active in the teaching and learning process (Asıçosoy & Özdamlı, 2016; Bautista, 2012; Selçuk, 2010).

There are some misunderstandings about the flipped-classroom. First, the flipped-classroom is not an online course where students work on the subject matter without structure. It is not designed to replace the teacher with videos. In the flipped-classroom, students should not study the concepts on a computer during class time. Rather, students are expected to take responsibility for their own learning with the help of increased interaction and personalized contact time between students and teachers (Butt, 2014; Milman, 2013). Absent students can easily follow the course activities with the opportunity to access permanently archived content, which can allow students to engage in their learning in a constructivist manner (Bergmann, Overmyer, & Wille, 2013).

To identify the factors that mediate the effect of the instructional approach, different variables must be investigated. Some of the factors could be the use of interesting, attention-grabbing videos, a sufficient amount of time for videos, students’ willingness, the percentage of completed homework, note taking during videos and listening to instead of watching videos. It was stated that students with high performance found videos less helpful than students with low or middle performance. The students participating in the study indicated that it was more convenient to listen to videos approximately 20 min long and to take notes while listening (Enfield, 2013).

Herreid and Schiller (2013) investigated case studies on flipped-classrooms from the National Center for Case Study Teaching in Science listserv. It was stated that the teachers preferred flipped-classrooms because students are more actively involved in the learning process; students who miss class can view the videos used; and the teachers can spend more time with students in class and understand the points where students have difficulty. Hence, these qualities provide teachers the opportunity to enhance students’ academic success and motivation. However, the researchers identified two major problems in the application of the flipped-classroom model, and they suggested two ways to address these problems. The first problem is students’ resistance to the change in study habits (Chen, Wang, Kinshuk, Chen, 2014). These types of students have difficulty in participating in class activities and group work because they are unprepared. The second problem is teachers’ difficulty in preparing materials (Bates & Galloway, 2012; Zheng, Becker, & Ding, 2014) and preparing (recording and editing) videos. To solve the first problem, the researchers suggest giving a short quiz or homework related only to the information in the videos. Students must be ready to take responsibility for their own learning (Hao, 2016). To solve the second problem, the researchers suggest using videos prepared by well-known sources or generating short-segment videos using various software programs, such as Camtasia, and then publishing them on YouTube or learning-management systems such as Moodle. In addition, class size could also be one of the problems in the application of flipped-classroom approach. In crowded classes, it might be difficult to handle all students’ needs (Butt, 2014).

Asıçosoy and Özdamlı (2016) adapted Keller’s Attention, Relevance, Confidence and Satisfaction (ARCS) motivation model to physics course enhanced with flipped-classroom in order to find out the effectiveness of flipped-classroom model on the achievement, motivation and self-sufficiency of students. 66 students (30 in control group and 36 in experimental group) were participated in pre-test and post-test experimental designs with control groups and mixed design that consisted of qualitative data. Achievement test was applied to both groups as pre-test and post-test. Belief scale and motivation questionnaire were applied to only experimental group as pre-test and post-test. At the end of the study, semi-structured interview were conducted. While control group studied the physics course in traditional approach, the experimental group studied the same topics in flipped-classroom approach for 8 weeks. It was found that the achievement of students in experimental group was significantly higher than students in control group. It was also found that motivation and self-sufficiency of students in flipped-classroom increased significantly. They indicated that perception of students in flipped-classroom approach were positive about watching video previous the course and these students expressed the new approach as effective and entertaining and, they would like to have other courses in the same manner.

There is a growing interest shown in flipped-classroom model at all level of education. For example, Hao (2016) explored 84 voluntarily participated undergraduate students’ perspectives concerning flipped-classrooms, learning readiness for flipped-classrooms and the effects of their personal characteristics in two undergraduate courses, “Information Technology and Education” and “Classroom Observation,” taught by the same instructor in department of education in Taiwan. Results gained from adapted survey and open-ended questions showed that more than 50% of the participants strongly agreed or agreed that flipped-classroom was a good experience and liked the idea of flipped-classrooms because of student-centered characteristics of the model. Students in two classes indicated that learning supplements, group works, more discussions with lecturer compared to traditional course and doing previews were good experiences and useful training for self-directed learning. However, some students complained about quizzes, the quality of group work and doing previews before class.
Even, one indicated that “What if all instructors adopt the flipped-classrooms? All courses would need previews! The students would want to die!” (Hao, 2016).

According to the results of recent research, the flipped-classroom model enhanced students’ cognitive thinking but did not improve their performance as expected (Marlowe, 2012; Zheng et al., 2014). The flipped-classroom model had positive effects on learning (Enfield, 2013), but one of the disadvantages stated by the participants was that it took much more time to prepare, and they did not get used to this model of learning (Zheng et al., 2014).

In 2014, Bormann investigated the effectiveness of a flipped-classroom for student engagement and achievement in comparison to a traditional classroom by analyzing more than thirty journal articles from mixed-method or qualitative studies in terms of different criteria. Bormann found that students in various disciplines preferred to study their courses in a flipped-classroom for the following reasons: to use class time actively (Chen, et al., 2014; Hao, 2016; McLaughlin et al., 2013), to have control over their learning (Enfield, 2013; Sohrabi & Iraj, 2016), and to control the video recording by pausing and rewinding (Butt, 2014). Bormann (2014) also indicated that most (almost 77%) of the students felt they were more engaged with the new classroom format (Chen et al., 2014; Davies, Dean, & Ball, 2013; Gaughan, 2014; Mok, 2014; Murphree, 2014; Willey & Anne, 2013). Approximately 77% of the students stated the importance of outside flipped tasks (Gaughan, 2014; Morin, Kecskemety, Harper, & Clingan, 2013; Murphree, 2014; Willey & Anne, 2013), and 90% received major support from the in-class activities (Davies et al., 2013; Hao, 2016; Morin et al., 2013; Murphree, 2014; Sohrabi & Iraj, 2016; Willey & Anne, 2013).

Although the engagement of students in flipped-classroom was high, their perceptions of the model were mixed. Most of them were enthusiastic about studying in a flipped-classroom because they thought that coming to school with known concepts allowed them to follow the content, to ask the teacher meaningful questions, and to give meaningful responses to questions. They liked following courses without time barriers (Davies et al., 2013; Findlay-Thompson & Mombourquette, 2014). Some students, however, did not want to watch videos outside the class, and they wanted the teacher to explain the content and to make necessary applications in the classroom (Aşksoy & Özdamli, 2016; Findlay-Thompson & Mombourquette, 2014; Hao, 2016; Sohrabi & Iraj, 2016). Moreover, one of the perceptions of students was that compared to the traditional classroom, they had more workload in the flipped-classroom (Hill, Riha, & Wysocki, 2014).

The majority of recent pertinent studies have found positive effects of the flipped-classroom model on academic success. Some of these studies found significant differences in achievement scores (Chao, Chen & Chuang, 2015; Hughes & Paulson, 2015; Mason, Shuman, & Cook, 2013; McLaughlin et al., 2013; Sengel, 2014). On the other hand, critics of flipped-classroom fear that changing the direction of learning may not take place expected impact on students. In the literature, it was also found that the achievement in flipped-classrooms was not significantly higher than that in traditional classrooms (Bell, 2015; Davies et al., 2013; Murphree, 2014).

This article reports a case study on using the flipped-classroom model to teach a physics course to second-year students in the Department of CEIT in the Faculty of Education at Uludag University. It presents the results of a two-year study in a university-level physics course. A traditional class model was used in one year, and a flipped-class model was used in the other.

The purposes of the study were (1) to evaluate the effectiveness of the flipped-classroom, coupled with problem-based learning and cooperative learning, and to compare it with that of a traditional classroom. This problem has been the focus of several studies on science courses (Bates & Galloway, 2012; Marlowe, 2012; Ruddick, 2012) and engineering courses (Mason et al., 2013); (2) to investigate the effectiveness of watching videos and the level of doing homework in succeeding in the physics course; and (3) to evaluate students’ perception of using the flipped-classroom format in the physics course. Previous research has indicated both a high level (Lage, Platt, & Treglia, 2000; Marlowe, 2012) and a low level (Strayer, 2012) of satisfaction with the flipped-classroom format

3. Method

3.1. Research design

In this study, both qualitative and quantitative data were collected. The purpose is to synthesize the quantitative and qualitative findings to describe understanding of phenomena in detail in the study and to make comparisons in different levels (Creswell & Clark, 2011). When researchers cannot artificially create groups and cannot apply the use of random assignment, quasi-experimental design, week design, can be used (Creswell, 2012). Hence, a pre-test/post-test quasi-experimental method with a control group was used. There was one control group (traditional instruction group) and one experimental group (flipped-classroom learning group). The Physics II course in the Department of CEIT at the Faculty of Education at Uludag University was used for this study. There was only one section taking the course and because of convenient accessibility of sample, a non-probability sampling technique, convenience sampling, was performed for 96 students (Wallen & Faenkel, 2011). Convenience sampling is a way of sampling in which selection is made purely on the basis of who is available (Ritchie, Lewis, Nicholls, & Ormston, 2013).

The course was studied for two years. In the first year, the traditional-classroom model was applied; in the second year, the flipped-classroom model was applied. In the second year, the same topics from the same textbook were covered, and the same instructor was employed. In both classes, the students were evaluated with one midterm, which contained 25 multiple-choice questions and counted 40% toward the final grade, and one final exam, which contained 30 multiple-choice questions and counted 60%. For the exams in both years, the instructor prepared the same number of questions with approximately the same difficulty level. One professor and one instructor teaching the same course in the Faculty of Education checked the internal consistencies of the exams. Students were required to solve problems and to do homework. At the end of each chapter, small pop quizzes with 4 questions were administered to students in both groups. Each course was composed of 3-h courses for 14 weeks, lectures for 13 weeks and one week for the midterm.

In the traditional-classroom model, in the first class session, the new topic was taught. The instructor solved problems related to the new topic and assigned homework problems from the course book. In every class session, in the first hour, problems (related to the previous week’s content) that could not be solved by students were explained by the instructor or by a discussion method and question/answer techniques. In the second and third class hours, new concepts were explained, and the instructor generally solved problems in the textbook related to these concepts. To let the students participate in active learning, the students in the group of two- or three-persons group solved problems in a certain time period.

In the second year, the course was taught through the flipped-classroom model which was the experimental group of the study. The instructor shared videos prior to the classroom, and students tried to solve at least one example from the textbook. Students had
to view videos outside of class time. Videos related to the topics were selected from YouTube. For every unit, two different sources using different approaches were selected. One of them explained topics on the white board, but the other did not. In proper situations, simulation or simple hands-on experiments were used to give detailed explanations. Meanwhile, for each topic, one or two videos for solving supplementary problems related to the required subject were selected. Each video was between 15 and 20 min long as Enfield (2013) stated that average duration of the videos had better be 20 min long. These videos were shared on YouTube for easy access.

During the 3 h of class time, the students first participated in discussions and problem-solving activities in groups of two or three. They tried to solve previously determined problems from the course book in a specified amount of time. Then, they tried to solve the similar problems individually. In both cases, they were free to ask the instructor questions. The instructor gave necessary explanations individually to the student or the group. With the guidance of the instructor, they found the answers. If most students could not solve one of the problem, then the instructor explained the solution on the board to the whole class. Then, in both groups, students were advised to solve the same type of problems outside of class.

To control for possible differences between the groups, the performance of students in the Physics I course were used as pre-test results. All students had to take the Physics I course from the same instructor through a traditional lecture approach in the previous spring semester. After the flipped- and traditional-classroom models were used for 12 weeks (6 weeks before the midterm and 6 weeks before the final exam), the final test was administered to measure achievement in the physics course. The performance of the students in the Physics II course was used as the post-test results. In addition, an online post-survey was used to examine students’ perceptions of the flipped-classroom model and its applications (Table 1).

3.2. Sample

The subjects of this study were second-year pre-service teachers who were enrolled in the Department of CEIF at Uludag University. In the traditional classroom, there were 81 students; 29 of them were taking this course for the second or third time. In the flipped-classroom, there were 56 students; 15 of them were taking the course for the second or third time. To reduce the effect of these students, their results were not included in processing. Therefore, there were 55 (28 female and 27 male) students in the traditional classroom and 41 (25 female and 16 male) students in flipped-classroom, as shown in Fig. 1.

3.3. Data-collection instruments

3.3.1. Achievement tests

Pre-service teachers’ achievement in the physics course was measured using the midterm and the final test scores. The researcher developed the midterm, containing 25 multiple-choice questions, and the final test, containing 30 multiple-choice questions with five options. The test was used to determine students’ knowledge related to the fundamental concepts, their skills on recalling the relationships between concepts, and their ability to apply them to problems. The questions were prepared according to the behavioral objectives and purposes in chapters, and they were written by matching the solved questions in each week. In the initial form, the midterm test and the final test contained 30 questions and 35 questions respectively. Two experts who taught physics at the Faculty of Education analyzed the test questions, and two questions were subsequently eliminated. Then, the revised form of the test was applied to 80 students that had previously taken the physics course. After the analysis, some questions were eliminated because of the low discrimination index. Finally, the achievement tests were administered with 25 questions for midterm and 30 questions for the final exam. As described above, the effects of the midterm and the final exams were %40 and %60 respectively for final performance results. The Cronbach’s Alpha reliability were found to be 0.81 for midterm test and 0.79 for final test (Cronbach, 1951).

3.3.2. Surveys

The online surveys were developed on Google Docs for experimental and control groups separately to measure preferences for the general perceptions about learning activities. The surveys included items related to the experiences in classrooms with and without the flipped-classroom model. Questions in both groups were grouped into Class Lectures, Homework Completion, Class Activities and Absence. Although the domains of the groups were the same, there were 18 items in non-flipped-classroom group and 16 items in flipped-classroom group. The number of items in each group were as follows respectively: Class Lectures; 6–4, Homework Completion; 7–7, Class Activities; 2–2 and Absence; 3–3. A variety of questions (e.g., perception of methods used, percentage of using video, percentage of doing homework, and the approximate number of times watching a video, types and number of class activities done) were included on a five-point Likert Scale (strongly disagree through strongly agree), multiple-choice interval

Table 1

The pretest-posttest quasi-experimental method with control-group model design.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Pre-test</th>
<th>Application</th>
<th>Exam</th>
<th>Application</th>
<th>Exam</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flipped</td>
<td>Physics – I performance</td>
<td>6 weeks</td>
<td>Midterm</td>
<td>6 weeks</td>
<td>Final</td>
<td></td>
</tr>
<tr>
<td>Traditional</td>
<td>Physics – I performance</td>
<td>6 weeks</td>
<td>Midterm</td>
<td>6 weeks</td>
<td>Final</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1. Number of subjects with respect to gender.
questions and open-ended comment sections. Three open-ended items were added to gain preferences for or against classroom activities and homework completion. The face validity of both surveys was confirmed by two experts. The reliabilities of the surveys instruments were measured by Cronbach’s Alpha. The reliability estimate for non-flipped-classroom and flipped-classroom surveys instrument are 0.80 and 0.84 respectively (Cronbach, 1951). No identifying information was taken from the students. In this study, only some part of collected data will be presented.

3.4. Data analysis

Students’ achievement in the Physics II course was statistically analyzed according to the type of method used. An independent-sample t-test, one-way ANOVA and the non-parametric Kruskal-Wallis test were used to determine the difference between the achievement in pre-test and post achievement tests and to compare the effect of homework-completion performance on achievement. A non-parametric test was used because of the violation of the normal distribution and the small sample size. A non-parametric Kruskal-Wallis ANOVA was performed with 4 subject groups as the independent variable and achievement as the dependent variable. SPSS 22.0 for Windows was used for data analysis. The significance level was determined to be 0.05. Descriptive statistics were used to present the data gathered from the surveys.

Investigating the qualitative data, the data from survey items and open-ended questions were analyzed at the same time to judge the results. This mixed method study is an emphasis on diversity at all levels of the research. This diversity on results can pioneer to comprehensive investigation of the phenomenon (Teddlie & Tashakkori, 2010; Creswell & Clark, 2011). Open-ended questions were analyzed thematically. Responses to these questions were coded and to support the findings, original expressions of participants were listed. Qualitative and quantitative methods were triangulated to increase the validity of the data by using different data sources (Bamberger, 2000; Flick, 2014). As Bamberger (2000) stated triangulation is also used in quantitative research. Moreover, it is used to compare findings of qualitative and quantitative studies.

4. Results

4.1. Student achievement

To identify any differences a priori between the flipped-classroom model and the traditional-classroom model, students’ performance in the Physics I course, as the pre-test, was compared. The mean scores on the pre-tests for the control group and the experimental group were compared using an independent-sample t-test with a significance level of 0.05. The pre-test mean score on the achievement of the flipped group (M = 47.59) was almost equal to that of the traditional group (M = 50.57), as shown in Table 2. There was no statistically significant difference between the groups, suggesting that the flipped-classroom model and the traditional model had similar backgrounds before changing the model used in teaching physics (t = −1.115, p < 0.05).

When the mean scores on the post-tests for the traditional group and the flipped group were compared using an independent sample t-test, there was a statistically significant difference between the groups, suggesting that the flipped-classroom model and the traditional-classroom model had a positive effect on achievement (t = −2.75, p < 0.05). The post-test mean score of the achievement of the flipped group (M = 51.40) was slightly higher than that of the traditional group (M = 45.78), as shown in Table 3.

4.2. Survey data

4.2.1. Effects of the performance of completing homework on student achievements

Survey data were collected from both groups (55 and 41 students from the traditional and flipped-classroom respectively) to examine whether there was a relationship between performance and the survey data. The participants were categorized into four groups with respect to their responses to the survey question: “What percentage of weekly assignments did you complete?” It was originally planned to categorize the students into five groups, but none of the students responded that they had completed less than 20% of the weekly homework. In the traditional group, 27.3% of students had completed 80–100% of the weekly homework (n = 15), 27.3% had completed 60–80% (n = 15), 27.3% had completed 40–60% (n = 15) and 18.2% had completed 20–40% (n = 10). In the flipped group, 39.0% of students had completed 80–100% of the homework (n = 16), 31.7% had completed 60–80% (n = 13), 17.1% had completed 40–60% (n = 7) and 12.2% had completed 20–40% (n = 5), as shown in Table 4.

To investigate the effect of the homework-completion performance on student achievement in the Physics course in the traditional classroom, one-way ANOVA was used. It was found that the percentage of homework completed affected student achievement in the traditional classroom [F(3, 51) = 4.752; p < 0.05] (Table 5). Post-hoc tests indicated a significant difference in the achievement scores between students who completed 80–100% of weekly homework and students who completed 40–60% of weekly homework, as shown in Table 6. However, no significant difference was found in the achievement scores between the other groups.

In the flipped-classroom, a non-parametric test was used because of the violation of the normal distribution and the small sample size. A non-parametric Kruskal-Wallis ANOVA was performed with 4 subject groups as the independent variable and achievement as the dependent variable. As shown in Table 7, the homework performance significantly affected (Ks > 17.7, p = 0.041) the achievement of students in the flipped-classroom. Post-hoc

Table 2

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>X</th>
<th>Sd</th>
<th>Df</th>
<th>t</th>
<th>Df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flipped</td>
<td>41</td>
<td>47.59</td>
<td>13.06</td>
<td>94</td>
<td>1.15</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>Traditional</td>
<td>55</td>
<td>50.57</td>
<td>11.26</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Table 3

Comparison of the post-test of Physics I achievement-test scores.

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>X</th>
<th>Sd</th>
<th>t</th>
<th>Df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flipped</td>
<td>41</td>
<td>51.40</td>
<td>11.33</td>
<td>2.75</td>
<td>94</td>
<td>0.01</td>
</tr>
<tr>
<td>Traditional</td>
<td>55</td>
<td>45.78</td>
<td>8.78</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4

Responses to survey question: “What percentage of weekly assignments did you complete?”

<table>
<thead>
<tr>
<th>Groups</th>
<th>Traditional classroom</th>
<th>Flipped-classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>20–40% completed</td>
<td>18.2% (10)</td>
<td>12.2% (5)</td>
</tr>
<tr>
<td>40–60% completed</td>
<td>27.3% (15)</td>
<td>17.1% (7)</td>
</tr>
<tr>
<td>60–80% completed</td>
<td>27.3% (15)</td>
<td>31.7% (13)</td>
</tr>
<tr>
<td>80–100% completed</td>
<td>27.3% (15)</td>
<td>39.0% (16)</td>
</tr>
</tbody>
</table>
analyses revealed that the students who completed 80–100% of homework showed significantly higher achievement than those who completed 60–80% of homework (z > 2.28, p = 0.023) and 40–60% of homework (z > 2.35, p = 0.019). However, completing only 20–40% of homework had no significant effect on student achievement.

In the flipped-classroom, students were asked about the number of teacher-announced videos; 41 students were categorized into four groups based on their responses. A non-parametric Kruskal-Wallis ANOVA was performed with the 4 subject groups as the independent variable and achievement as the dependent variable because of the violation of the normal distribution and the small sample size. These four groups showed no significant difference in student achievement in terms of the number of videos watched (Kruskal-Wallis ANOVA Ks = 1.76, p = 0.42) in the flipped-classroom.

4.2.2. Student perceptions

The surveys were used to identify the perceptions of students regarding the methodologies in the teaching-learning process. The surveys asked students to remark on their desired homework frequency per week (occasionally, a few times, sometimes, or often). The students in the traditional classroom preferred to have less homework (occasionally = 23 (47.27%), a few times = 12 (21.82%) sometimes = 12 (21.82%), often = 8 (14.55%)) than those in the flipped-classroom (occasionally = 4 (9.76%), a few times = 10 (24.39%), sometimes = 16 (39.02%), often = 11 (26.83%)). The survey asked students to specify the reasons they did not complete homework. The traditional class gave a higher rating score (M = 4.25 and M = 4.35) than the flipped class (M = 2.14 and 2.95) to the statements “I could not complete my homework because a simple question caught in my mind was blocking my progress” and “I could not complete my homework because I could not ask anyone when I needed help on the homework”, respectively. (Strongly agree = 5, agree = 4, neutral = 3, disagree = 2, strongly disagree = 1).

In the survey, students were allowed to implement their general opinions about the teaching-learning process in open-ended questions. Students had mixed responses. Some of them enjoyed studying courses via this concept, and it motivated them to study. For instance:

In class activities, I could easily ask my classmates and the lecturer questions, and this made me feel relaxed and happy.

I liked studying activities and solving problems in groups.

Some of the students in the flipped-classroom stated that they needed to spend more time on studying for the course. Otherwise, it was difficult follow the topics in the course hour. Therefore, meaningful learning occurred, resulting in improved grades. They watched online lessons and solved homework during class time to support their learning. This encouraged them to study more than they had expected. For instance:

I like this way of learning because I came to class ready after watching related topics, and then, I could easily adapt to what lecturer taught and solved related problems in class activities.

Although I spent more time studying than before, I enjoyed it. Watching video, pausing and taking notes increased my interaction with the course. As much as I tried, I feel that I could do difficult concepts in this manner.

However, one concern was that they did not get used to studying in pre-class activities:

When I got used to it, it was easy to follow. But at the beginning, it was difficult to adapt to the system.

When I did not watch the video before coming to class, it was at first difficult to solve problems. I needed help. But it was impossible for the lecturer to conclude the entire topic just for me. However, sometimes I could ask my classmate and get feedback from them.

I did not like watching at home. I think that lecture should be done in class. The lecturer explains, and I take notes. If there is a problem, one can ask at any time. No need for video ...

An interesting response discussed the class size and lecture format:

The classroom was very crowded. The lecturer tried to help and give feedback to all my classmates. But sometimes there were too many people asking for help.

Students in the traditional classroom criticized the process in terms of different aspects:

<table>
<thead>
<tr>
<th>(I) group</th>
<th>(J) group</th>
<th>Mean difference (I–J)</th>
<th>Std. error</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tukey HSD</td>
<td>20–40%</td>
<td>2</td>
<td>3.967</td>
<td>3.206</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>−0.860</td>
<td>3.206</td>
<td>0.933</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>−6.767</td>
<td>3.206</td>
<td>0.163</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>−10.733</td>
<td>2.867</td>
<td>0.003</td>
</tr>
<tr>
<td>60–80%</td>
<td>1</td>
<td>0.860</td>
<td>3.206</td>
<td>0.933</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4.827</td>
<td>2.867</td>
<td>0.343</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>−5.907</td>
<td>2.867</td>
<td>0.180</td>
</tr>
<tr>
<td>80–100%</td>
<td>1</td>
<td>6.767</td>
<td>3.206</td>
<td>0.163</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10.733</td>
<td>2.867</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>5.907</td>
<td>2.867</td>
<td>0.180</td>
</tr>
</tbody>
</table>

Table 5
ANOVA results for homework performance in traditional classroom.

<table>
<thead>
<tr>
<th></th>
<th>Between groups</th>
<th>Within groups</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>879,127</td>
<td>314,783</td>
<td>402,910</td>
</tr>
<tr>
<td>F</td>
<td>4,752</td>
<td>61,662</td>
<td>0.005</td>
</tr>
</tbody>
</table>

Table 6
Comparison of achievement with respect to percentage of homework completed in traditional classroom.

<table>
<thead>
<tr>
<th></th>
<th>Mean rank</th>
<th>χ²</th>
<th>df</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>20–40% completed</td>
<td>5</td>
<td>17,70</td>
<td>8,277</td>
<td>3</td>
<td>0.041</td>
</tr>
<tr>
<td>40–60% completed</td>
<td>7</td>
<td>14,86</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60–80% completed</td>
<td>13</td>
<td>17,42</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80–100% completed</td>
<td>16</td>
<td>27,63</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7
Non-parametric Kruskal-Wallis for homework performance in flipped-classroom.

<table>
<thead>
<tr>
<th></th>
<th>Mean rank</th>
<th>χ²</th>
<th>SD</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>20–40%</td>
<td>5</td>
<td>17,70</td>
<td>8,277</td>
<td>0.041</td>
</tr>
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<td>40–60%</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>60–80%</td>
<td>13</td>
<td>17,42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80–100%</td>
<td>16</td>
<td>27,63</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
I could not complete my homework because a simple question caught in my mind was blocking my progress. Because of this, I think homework is useless.

I could not complete my homework because I could not find anyone to solve problems when I needed help with the homework.

In the class, I could not take notes. If I did, I could not listen or understand. But in this case, I did not have any information to study while solving problems at home.

5. Analysis and discussion

The results of the study revealed the importance of homework in both traditional-classroom and flipped-classroom approaches. There was positive effect of the amount of homework completed on achievement in the physics course. One could argue that as the homework completion rate increases, the rate of achievement would be expected to increase; however, that was not the case in this study. Although there was no linear relationship between the homework completion rate and achievement in the traditional classroom, there was such a linear relationship in the flipped-classroom. In the traditional classroom, there was a significant difference between the students who completed almost all homework (80–100%) and those who completed only half of it (40–60%). However, there was no significant difference between the students who completed almost half of the homework (40–60%) and those who completed almost all of the homework (60–80%). In the flipped-classroom, however, the increase in duty will result in increased success because doing homework at school leads to high interaction with peers and the lecturer, a high rate of participation, a high level of engagement in the course and high achievement scores. This findings corroborates the findings of others (Bormann, 2014; Mason et al., 2013; McLaughlin et al., 2013; Milman, 2013; Morin et al., 2013; Mok, 2014; Şengel, 2014). One of the surprising results was that there were no significant differences between doing most of the homework and doing less homework in the two approaches. The small number of participants in the groups might explain these unexpected results.

The results were consistent with the results of previous studies. Active learning strategies and problem-solving strategies would help students and enhance their learning in case students were well prepared for class (Asiksoy & Ozdamlı, 2016; Butt, 2014; Chen et al., 2014; Davies et al., 2013; Findlay-Thompson & Mombourquette, 2014; Murphree, 2014). Hence, if the students were well prepared before class, they generally enjoyed flipped-classroom activities. This leads to increase in motivation of students in studying physics concepts.

6. Limitations

There are some limitations in this study. First, the study was investigated in one department of faculty of education by using particular sample at a state university in Turkey. The results may not be generalized to other disciplines. The study was accomplished in two years with the same instructor. So, doing a random assignment was not possible. The results cannot be generalized to other students. Future researchers need to replicate this study in more than two classrooms and in different departments to make random assignment and to confirm the results.

The second limitation was related to the data that were based on achievement test and surveys. In-depth qualitative analyses, like observation and interview methods, can be recommended. Hence, more comprehensive results can be generalized by triangulating the results. Moreover, only one instructor applied the flipped-classroom method to one class. The perceptions of the instructor about flipped-classroom and the way he introduced the new method may affect the responds of students.

The survey was limited with four domains; Class Lectures, Homework Completion, Class Activities and Absence. However, different factors may have led to success of flipped-classroom. Learning styles, attitude, course content, demographic characteristics of students and active learning strategies may have an effect on success or failure of a model. Future study is suggested to further investigate the impact of different domains to find the relationship with flipped-classroom.

In this study, videos related to the topics were selected from YouTube. For every unit, two different sources that used different approaches were selected and shared on YouTube for easy access. The researcher tried to select videos that teach the same topic by using a similar narrative technique. However, students get used to using a similar narrative technique. Therefore, future research is suggested to record own course video and share them in a learning management system to control logs of students.

7. Conclusions

The research questions aimed to evaluate the effectiveness of the flipped-classroom model, when coupled with problem-based learning and cooperative learning, compared to that of a traditional classroom. They also aimed to identify the perceptions of students for physics education. The Physics II course in the Department of CEIT at the Faculty of Education at Uludag University was used for this study. The course was studied for two years. In the first and second years, the traditional-classroom flipped-classroom models, respectively, were implemented using the same topics covered in the same textbook.

Comparisons of student performance on midterm and final exam questions were promising. When looking at the achievement test results, the flipped group performed statistically better on final test. This finding is consistent with the fact that the flipped-classroom offering more class time to solve problems and discussion and group work than did the traditional classroom offering (Bormann, 2014). The findings are consistent with Asiksoy and Ozdamlı’s (2016) study proves that active learning strategy increased the achievement of students in physics course. Enabling students to participate in discussions and having free time to demonstrate different teaching methods like and being ready to class by watching video before class motivated the students in flipped-classroom model.

The results of this study have shown that students in the flipped-classroom enjoyed the activities and prepared for class at home by watching video and doing preliminary homework. They liked this approach because they could use the properties of video (e.g., pausing, taking notes) and could easily follow lecturer, and they felt comfortable asking questions at any time needed. As Enfield (2013) indicated; watching video with appropriate duration and taking notes are conventional ways of studying. Moreover, active learning strategies and group work were preferred activities. All of these activities increased student engagement in the physics course. The result of this study is consistent with Hoa’s study (2016), indicating that being active in learning process with the help of group work and more time in discussion leads to increase in engagement and achievement. As Sobrabi and Iraj (2016) indicated students want to study in different environments that motivate and at the same time force to be engaged in learning. Mason et al. (2013) and McLaughlin et al. (2013) stated that a high level of
engagement develops high achievement scores. Gales and Galloway (2012) stated that although students strain to adapt to the new system at the beginning, students who know and feel responsible for their own learning can close the gap with more individual and group activities and can achieve better grades. However, students in the traditional classroom preferred to have less homework because of the inability to solve problems and the lack of required support.

In the literature, as observed in this study, it is possible to conclude that the flipped-classroom model is more suitable for students who cannot manage to maintain effective study habits outside the classroom. It is more suited for motivated learners. The flipped-classroom model has the potential to improve learning in the case of spending additional time and resources as student-centered learning strategies are applied. Moreover, although students struggled to adapt to the new system at the beginning, students who know and feel responsible for their own learning can close the gap with more individual and group activities and can achieve higher grades. As Hao (2016) indicated, to flip or not to flip is not a matter if the students take their own responsibility of learning and if instructors are aware of students’ learning needs.

As a instructor and a researcher of this study, I could inform that the role of teacher and a part of the content to be considered as Butt (2014) indicated. In some applications, dealing with students’ need was difficult. Future researchers need to investigate appropriate number of students in a classroom for ideal flipped-classroom activities.

To improve 21st century skills—e.g., analyzing and solving problems effectively by collaborating with others, being able to access information from different sources, taking initiative to learn skills, and being responsible for one’s own learning—it is important to use flipped learning in educational activities. Similar studies in various disciplines including more samples may be designed to investigate the possible effects of flipping. If a teacher can achieve these types of results in a physics course with flipped learning, they can easily achieve these results in other courses.

References


Bormann, J. (2014). Affordances of Flipped Learning and its Effects on Student Engagement and Achievement. Master of Arts. Iowa: University Of Northern Iowa, Division of Instructional Technology Department of Curriculum and Instruction.


Camel, C. (2011, 01 08). An evaluation of the flipped classroom. Retrieved April 5, 2013, from http://www.e-bookspdf.org/view/aHR0cDovL2NhbWVscG9ydGZvb24ubmV0d2FyZ2VhLmJ1L0FtZGl0aW9ucy5zb3V0LmNvbS5jb20=.jpg. (QV4xZixbhlVhdGibvibFZBDYWI0YXn5BbQmqVChlEi5axaWbzwQGxkh3cyNyb29t.


Enfield, J. (2013). Looking at the impact of the flipped classroom model of instruction on undergraduate multimedia students at CSUN. TechTrends, 57(6), 14–21.


