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Examining the effectiveness of discussion-oriented flipped learning environments

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Abstract: The overall aim of the study was to examine the effects of the discussion-oriented flipped learning environments on the achievements, satisfaction levels, and high-ordered thinking skills of students. This semi-experimentally planned research was prepared in accordance with the 3x2 factorial design and conducted with a group of 190 second-year coeducational students attending their undergraduate education at Uşak University. A six-week application was conducted with three groups of students, who were classified as participating in discussions in the newly-developed discussion-oriented flipped learning environments with mandatory, voluntary, and non-attendee participation status. As the data collection tool of the research, achievement tests consisting of multiple choice and open-ended questions were used together with the satisfaction scales (related to videos, discussions, and general environment) developed by the researcher. As a result of the posttests applied after the application, it was determined that the overall achievement scores of the students, who participated in the discussions in discussion-oriented flipped learning environments, were significantly higher than those who did not participate in the discussions. It was determined that there was statistically no significant difference between the satisfaction levels of students concerning the videos, while the discussion satisfaction levels of students who participated on a mandatory basis were statistically significantly higher compared to those who participated on a voluntary basis. In terms of high-ordered thinking skill scores, it was determined that mandatory or voluntary participation in discussions in flipped learning environments have a significant and positive impact on high-ordered thinking skills, in comparison to the non-participation.

1. INTRODUCTION

In parallel with the ongoing development of technology, different technological methods and techniques are developing in the education field in an attempt to include them into the teaching and learning processes. In particular, the development of communication technologies as well as devices with internet connection have paved the way for efforts to benefit from these technologies in the education field. In this continuous development and change, the meanings and expectations attributed to teaching and learning processes are changing and becoming

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diverse. As part of this change and development, the needs and expectations of students differ, and different learning models and methods are emerging in response to these expectations (Yeşilyaprak & Partners, 2015). One of these different and new methods is the flipped class concept, which was first used by M. Lage, G. Platt and M. Treglia in the 2000s (Ng, 2015). The first studies and the first ideas about this concept were also emphasized by J. Wesley Baker (2000), who was a K12 teacher at the time (Bates et al., 2017).

In the flipped learning, the learning process in the classroom was replaced with the non-classroom processes. In this context, the classroom teaching was transferred to non-classroom environments, and out-of-school activities were taken into the classroom (Baker, 2000; Ng, 2015). Simply put, flipped learning is a learning process in which students watch the videos prepared as a course material at home and implement the practices and exercises given as homework face-to-face in the classroom environment (Bergmann & Sams, 2014).

When the literature is examined, it is seen that there are both positive and negative views about the flipped learning method. Advantageous aspects of flipped learning can be listed as follows: it supports student-centered teaching (Blau & Shamir-Inbal, 2017; Milman, 2012). Students can watch videos whenever and wherever they want (Davies et al., 2013; Enfield, 2013; Marwedel & Engel, 2014, Ramaglia, 2015). It supports students to be able to do teamwork (Blau & Shamir-Inbal, 2017; Marwedel & Engel, 2014). Students can progress at their own pace (Davies et al., 2013; Enfield, 2013; Lee & Park, 2018; Milman, 2012; Ng, 2015; Ramaglia, 2015). It saves time (Bergmann & Sams, 2012; Milman, 2012). Increases student–teacher and student–student interaction (Bergmann & Sams, 2012; Blau & Shamir-Inbal, 2017; Hung, 2018; Lee & Park, 2018). Problems experienced by students concerning non-classroom learning can be eliminated with accompaniment of teacher through classroom activities (Torun & Dargut, 2015). It is scalable, whereby it can be applied to more crowded classrooms (Davies et al., 2013). Offers students the opportunity for collaborative learning (Brewer & Movahedazarhouligh, 2018; Lee & Park, 2018; Strayer, 2012). Develops critical thinking and problem-solving skills of students (Lee & Park, 2018). It allows students to get prepared before classroom learning activities (Lo & Hew, 2017). It allows students to practice in the classroom (Topalak, 2016). It allows teachers to receive more feedback about students (Ramaglia, 2015).

Besides the advantageous aspects of flipped learning in the literature, it was also reported that there are some limitations and disadvantages in the application and functioning of the method. The researchers reported the disadvantages of flipped learning in their findings resulting from their descriptive and experimental studies. The disadvantages of the flipped learning method can be listed as follows: Failure to be sure whether videos are watched or not (Acedo, 2019; Milman, 2012; Turan & Göktaş, 2015). The obligation for students to collaborate among themselves (Acedo, 2019). Students have difficulty in interacting with the teacher and other student friends (Aydın & Demirer, 2016; Bhagat et al., 2016; Gündüz & Akkoyunlu, 2016; Milman, 2012; Nouri, 2016; O'Flaherty & Phillips, 2015). Students feel lonely and isolated in front of the video material (Du et al., 2014; Jerkins, 2017; Milman, 2012; Nouri, 2016; Talbert, 2012). Students have no chance to ask questions to their friends or teachers (Bhagat et al., 2016; Milman, 2012; Turan & Göktaş, 2015). Students cannot receive feedback outside the classroom (Gündüz & Akkoyunlu, 2016; Turan & Göktaş, 2015). The possibility of the student to come to class without watching a video lesson (Gündüz & Akkoyunlu, 2016; Milman, 2012). Students have difficulty in establishing a relationship of meaning between subjects (Chowdhury, 2017). The method requires fast internet connection and hardware (Acedo, 2019; Du et al., 2014; Jerkins, 2017; Krueger, 2012; Ramaglia, 2015; Turan & Göktaş, 2015). It is impossible to determine to what extent the students learn outside the classroom (Du et al., 2014; Gündüz & Akkoyunlu, 2016; Krueger, 2012, Talbert, 2012). There is a need for students to be motivated and their satisfaction level can decrease (Du et al., 2014; Gündüz & Akkoyunlu,

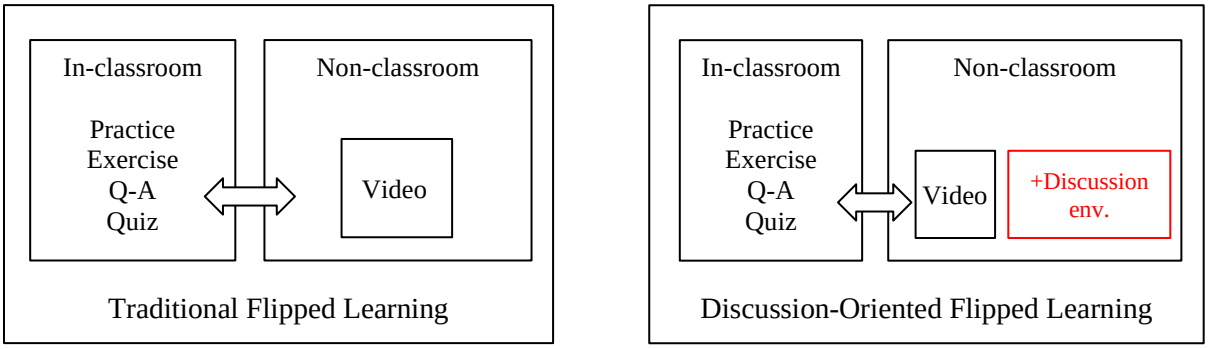
2016; Krueger, 2012; Talbert, 2012; Yılmaz, 2017). Making videos may be difficult for teachers (Acedo, 2019; Du et al., 2014; Gündüz & Akkoyunlu, 2016; Milman, 2012; Ramaglia, 2015; Talbert, 2012).

It is foreseen that staying alone with the video material after the school, feeling themselves alone and isolated, and being unable to communicate and cooperate with other fellow students in the learning process will have a negative impact on the learning process and decrease the motivation and performance levels of the students who are attending their education in the flipped learning environments. Therefore, it was envisaged that more effective and efficient teaching–learning processes can be achieved by eliminating these disadvantages and limitations (Acedo, 2019; Aydın & Demirer, 2016; Bhagat et al., 2016; Bolat, 2016; Davis et al., 2013; Du et al., 2014; Gündüz & Akkoyunlu, 2016; Jenkins, 2017; Krueger, 2012; Milman, 2012; Ramaglia, 2015; Turan & Göktaş, 2015).

In online learning, various means of interaction and communication can be used to address such negative situations. It is reported in the literature that increasing the number of interaction tools and learner interactions in online learning environments in various dimensions can also increase success (Üstündağ, 2012). For example, if a discussion environment is applied in the flipped learning process, learners can interact with each other and with their instructors, and these interactions can also have a positive impact on the achievement and satisfaction levels of the learners (Zainuddin, 2018). Burch (2013; Quoted in Tetreault, 2013) stated that when students are alone in front of a video material available to them for teaching purposes in non-classroom learning environments, their certain needs such as asking questions, interacting, searching for different learning resources can be addressed in a discussion environment that will take place in a flipped learning environment. Chowdhury (2017) stated that students in flipped learning environments may feel isolated, which in turn may result in misunderstanding the content and inability to connect important concepts. In order to avoid this kind of limitations, it was proposed to use the online discussion media in flipped learning environments.

In this context, it is envisaged that some of the disadvantages mentioned in the literature, such as being unable to interact, feeling isolated, not being motivated, not being able to ask questions, not being able to cooperate, not being able to connect the subjects, and experiencing a decline in performance can be eliminated by an "asynchronous online discussion environment" integrated with the flipped learning environment (Figure 1).

Figure 1. *The discussion-oriented flipped learning environment.*



In this context, it emerged as a necessity to use online discussion environments to eliminate some of the disadvantages of flipped learning environments and to examine the impact of this implementation on the learning-teaching processes. From this point on, the overall aim of the study was determined as examining the impacts of undergraduate students' participation in non-classroom online discussion activities in flipped learning environments on their academic achievement, satisfaction, and high-ordered thinking skills. In line with this overall aim, answers are sought for the following questions: Is there a difference among the overall

achievement scores of students based on their participation in discussions in a discussion-oriented flipped learning environment? Is there a difference among the satisfaction levels of students based on their participation in discussions in a discussion-oriented flipped learning environment? Is there a difference among the high-ordered thinking skill scores of students based on participation in discussions in a discussion-oriented flipped learning environment?

2. METHOD

This semi-experimental research was conducted in accordance with the 3x2 factorial design, taking into account the number of study groups and repeated measures. Accordingly, the first of the factors of the factorial pattern, which includes repeated measures, is the state of participation in discussion environments (mandatory, voluntarily, and non-attendance), which is the independent variable. The second factor is the two-level measurement variable consisting of "pretest and posttest", which is employed to measure the change in achievement according to tests. The dependent variables of the research are achievement, satisfaction, and high-ordered thinking skills. The symbolized version of the research model is shown in Table 1.

Table 1. *Research model.*

Study Groups	Pretest	Implementation	Posttest
GR1 (Mandatory)	M_{1-1}	Mandatory participation in discussions	M_{1-2}
GR2 (Voluntary)	M_{2-1}	Voluntary participation in discussions	M_{2-2}
GR3 (Non-attendee)	M_{3-1}	Not participating in discussions	M_{3-2}

$M_{1\text{-}1,2\text{-}1,3\text{-}1:}$ Pretest implemented to the groups: Achievement, high-ordered thinking.

$M_{1\text{-}2,2\text{-}2,3\text{-}2:}$ Posttest implemented to the groups: Achievement, high-ordered thinking, satisfaction.

The study group was comprised of 190 students who were attending Uşak University in the fall semester of 2018 academic year and who were receiving Computer Programming courses from the Faculty of Education, Computer Education and Instructional Technologies Department; Faculty of Science, Department of Mathematics; Faculty of Economics and Administrative Sciences, Department of Econometrics. Each class is divided into three groups of students who are participating in discussion activities in a flipped learning environment mandatorily (N: 69), voluntarily (N: 61), and non-attendee (N: 60).

The students in the mandatory group are the ones who are required to participate in discussion activities in a discussion-oriented flipped learning environment. Students in this group were required to submit a discussion topic / discussion question and participate in discussions opened by their friends. The students in the voluntary group are the students whose participation in discussion activities in a discussion-oriented flipped learning environment is optional. The participation of the students in this group in the discussion activities is subject to their own wishes. The students in the non-attending group did not participate in any discussion activities. There was no discussion in the flipped learning environment in which these students were present.

2.1. Data Collection Tools

In scope of the study, in order to measure the achievement, which is one of the dependent variables, achievement pretest and posttest consisting of multiple-choice questions were applied as well as high-ordered thinking skills pretest and posttest consisting of open-ended questions. Two separate achievement tests were developed to measure the students' achievements in the Go Programming course before and after the experimental procedure. The dependent variable of achievement was evaluated with the scores obtained from two basic measurements as pretest and posttest. Both achievement tests consist of questions from the same subject that meet the same gains. While the achievement pre-test was administered before the six-week application

period, the achievement post-test was administered after the six-week application period. To reliability analysis of achievement tests, a draft pretest and posttest of 40 questions were applied to 28 students from Uşak University, Department of Mathematics, who had previously taken Go Programming course. Sufficient time was given to the students in their test solutions. In line with the data obtained from the answers given by the students to the test, item analysis was performed on the draft pretest and posttest achievement tests. In line with the data obtained, item difficulty and item discrimination indices were calculated. The difficulty index of the achievement pretest, which was consisting of 12 multiple choice questions developed by the researcher and the instructor, was calculated as 0.50 (medium difficulty) and the distinctiveness average as 0.56 (very good). The KR-20 reliability coefficient, one of the indicators of internal consistency of the test, was calculated as 0.70 (reliable) for the achievement pretest. Additionally, the difficulty index of the achievement posttest consisting of 12 multiple choice questions was 0.52 (medium difficulty) and the distinctiveness average was 0.57 (very good). The KR-20 reliability coefficient, which is one of the indicators of internal consistency of the test, was calculated as 0.73 (reliable) for the achievement posttest.

In order to measure the level of satisfaction, which is another dependent variable of the research, the satisfaction scales were used, which were developed by the researcher consisting of three sub-scales. During the development of the scales, the draft scales were first examined in terms of content and construct validity. Within the scope of the content validity study of the draft scales, opinions were received from 9 field experts, one of whom was a Turkish Language expert. The experts examined whether the scale items were appropriate for the purpose and whether they were understandable in terms of language. Some items have been corrected. Within the scope of the construct validity study of the draft scales, 161 students who were studying in the second year of the Faculty of Communication at Uşak University were studied. The students tested the developed environments and then answered the scales. Video satisfaction is a sub-scale developed to measure the satisfaction levels of students towards the course videos. This scale was applied to all three groups of students. As a result of the reliability analysis of the 15-item video satisfaction sub-scale, the Cronbach Alpha reliability coefficient was calculated as α=0.95. Discussion satisfaction is a sub-scale developed to measure the satisfaction levels of students in the discussion environment embedded in the flipped learning environment and learning processes therein. This sub-scale was applied only to two groups of students who participated in the discussion environment on a mandatory and voluntary basis. As a result of the reliability analysis of the 10-item discussion satisfaction sub-scale, the Cronbach Alpha reliability coefficient was calculated as α=0.96. General environment satisfaction is a sub-scale developed to measure the satisfaction levels of students about the flipped learning system developed by the researcher. This sub-scale was applied to all the students in three study groups. As a result of the reliability analysis of the 10-item general environment satisfaction sub-scale, the Cronbach Alpha reliability coefficient was calculated as α=0.94.

High-ordered thinking skills pretest and posttest, each consisting of 5 open-ended questions, were used in order to reveal the overall achievement scores of students experiencing the newly developed environment, and to investigate its reflection on the higher-ordered thinking skills of them. Demirtaşlı (2010) stated that written exams consisting of open-ended questions, projects or self-assessments can be used to measure students' high ordered thinking skills. Similarly, Wright (2010) stated that open-ended questions can be used to measure higher-order thinking skills. Open-ended questions are those that allow the student to answer freely, and the correct answer can be expressed in different ways. The test, which consists of open-ended questions, is a parallel measurement tool with a similar scope to the achievement tests consisting of multiple-choice questions prepared for the Computer Programming course. In order to test the high-ordered thinking skills of students, two measurement tools which were

consisting of a total of 10 open-ended questions prepared by two field experts were developed following the content validity analysis. In the process of developing open-ended questions, a content validity study was conducted with five field experts. In line with the feedback from the experts, a revision study was carried out on the open-ended questions. Answers to open-ended questions consist of texts in which students convey their free thoughts and experiences and may reflect all or part of the ideal one-to-one answer (Karadeniz, 2016). Therefore, different types of methods such as classification according to other question types (good-moderate-poor) or grading (0-5) can be used while scoring. Within the scope of this research, a rubric was used.

2.2. Newly Developed Environments

The newly developed learning environment was designed as three different environments under two types: *with-discussion* and *without-discussion* environments. While there was a discussion environment in the settings of the students who participated in the discussions either mandatorily or voluntarily, there was no discussion environment in the flipped learning environment in which the students of the non-attendee group participated. The environment was developed for teaching the Go programming language within the scope of Computer Programming course. The six-week course videos were shot and prepared in a professional studio environment by the researcher together with the course instructor, and then they were placed in the three newly-developed environments. In addition, questions are embedded in the videos in order to ensure that the videos are viewed. The newly-developed discussion-oriented flipped learning environments were examined by nine field experts before the application, and they were asked to make an assessment. In accordance with feedback from the experts, a student group consisting of 42 students apart from the study group was asked to experience the environment, participate in the preliminary applications, and then make an evaluation. After taking into account the feedback from the students, the environment was put into its final form with necessary revisions.

2.3. Application Process

Discussion environments are prepared in asynchronous structure. There were no moderators in the discussion environments. Discussions were conducted within the framework of the Go Programming Language in which this application is run. The students were able to open any discussion topic they wanted and answered the discussion topics of their friends.

Before the six-week application process began, orientation meetings were held with all students. Detailed information was provided in the orientation meetings in certain subjects such as access to the system, use of the system, information about videos, and a number of activities that students can do within the system (watching video, answering video questions, participating in discussions, scoring, etc.). A different meeting was arranged with the students in the mandatory participation group in a different time, and they were guided about that participation in the discussion in the system is mandatory, they should participate in the discussions throughout the process and initiate discussion topics, and it is also mandatory to ask questions and write answers for the subjects initiated by other friends.

Students whose participation in discussions was mandatory within the framework of non-classroom application activities watched the course videos and answered questions while they were watching. Students in the mandatory group watched the videos, mandatorily participating in discussions and responding the subjects their friends addressed. Students of the non-attendee discussion group watched course videos and answered the questions embedded in videos without any discussion environment. The lecturer did not participate in the discussions, preventing the existence of any authority or moderator in the discussion environments.

Within the framework of classroom application activities, students carried out face-to-face weekly applications with the instructor in line with the course follow-up process. In the flipped

learning environment based on the video course content concerning the subjects specific to the Go Programming Language, students carried out activities by writing codes in the laboratory environment. Sample code writing exercises have been performed continuously in the classroom environment. The class learning process was carried out in the same way in all groups.

2.4. Data Collection

Before the application, the achievement pretest including multiple-choice questions was administered to the students, and similarly, the high-ordered thinking skill pretest including open-ended questions was implemented in order to measure the achievement levels. After the six-week application process, students were administered the achievement posttest consisting of multiple-choice questions, the high-ordered thinking skills posttest consisting of open-ended questions, and satisfaction sub-scales (concerning the videos, discussions, and general environment). Satisfaction sub-scales concerning the videos and general environment were administered to the whole study groups, while the discussions satisfaction sub-scale was applied to the students participating in the discussions in the voluntary and mandatory groups, but not to the students from the non-attendee group that did not participate in the discussions. All activity records of students during the six-week discussion-oriented flipped learning environment were obtained from their logs on the system.

2.4. Data Analysis

The overall success score was calculated by adding 50% of the achievement test scores consisting of multiple-choice questions and 50% of the achievement test scores consisting of open-ended questions. One-way variance analysis (ANOVA) was used in the analysis of the overall achievement pretest and posttest scores. When the pre-application overall achievement pretest scores were analyzed, it was determined that there was no difference among the groups, and since the groups demonstrated a homogenous distribution, the analyses were made over the posttest scores. Therefore, instead of analysis of covariance, one-way variance analysis (ANOVA) was employed for the three groups through posttest scores. The possible differences among the satisfaction and overall achievement scores of the three participant groups in the study were interpreted as a result of their participation in the discussions.

In the analysis of the data obtained from satisfaction sub-scales (video, discussion, general environment), it was examined whether they were suitable for parametric analysis, and it was decided to employ one-way variance analysis (ANOVA). Independent samples t-test was used in the analysis since the data obtained from the satisfaction scale concerning discussions were applied only to the two groups of students participating in discussions mandatorily (GR1) and voluntarily (GR2).

10 open-ended questions (five pretests and five posttests) prepared to measure high-ordered thinking skills were rated by four different experts. The high-ordered thinking skill score was obtained by taking the average of the scores given by these four experts. The reliability between the scorers was calculated through the intraclass correlation coefficients. The analysis about whether the scores of high-ordered thinking skills pretest and posttests, which were consisting of open-ended questions, differ among the groups was tested through one-way variance analysis (ANOVA).

3. FINDINGS

3.1. Findings and Interpretations Concerning the Achievement Variable

The findings of the students concerning the achievement variable were obtained from the pretest implemented before the application and the posttest after the application.

Table 2. *Mean and standard deviation values of the students in the groups concerning the pretest-posttest overall achievement scores.*

Groups	*N*	Pretest		Posttest	
		$\bar{X}$	*Sd*	$\bar{X}$	*Sd*
GR1 – Mandatory	69	14.31	9.66	42.41	14.69
GR2 – Voluntary	61	14.25	8.12	42.58	13.23
GR3 – Non-Attendee	60	13.96	8.85	33.43	14.59
Total	190				

Examining Table 2, according to the pretest and posttest overall achievement scores, the average achievement scores of students who participated in discussions in flipped learning environments was $\bar{X}$=14.31 before the application, whereas it was $\bar{X}$=42.41 after the application. The mean achievement score of students participating in the discussions was $\bar{X}$=14.25 before the application, while it was $\bar{X}$=42.58 after the application. The mean achievement score of students in the group that did not participate in the discussions was $\bar{X}$=13.96 before application, and $\bar{X}$=33.43 following the application. Based on the assessment of these mentioned figures, it can be stated there is an increase in the overall success scores of all students.

As a result of the one-way variance analysis (ANOVA), which was implemented to determine whether there was a significant difference among the overall achievement scores of the students participating in the learning process in three different experimental environments, it was determined that there was statistically no significant difference [$F(2,187)=0.027$; $p>.05$]. This finding was interpreted that the prior knowledge levels of students about Computer Programming course before the application were similar. The results of the one-way variance analysis (ANOVA), which was implemented to determine whether there was a significant difference among the overall achievement scores of the students participating in the learning process in three different experimental environments after the application, are given in Table 3.

Table 3. *One-way variance analysis (ANOVA) of the posttest overall achievement scores of the student groups.*

Source of the Variance	Sum of Squares	*Sd*	Mean of Squares	F	*p*	Significant Difference
Intergroup	3336.257	2	1683.129	8.334	.000	GR1-GR3
Intragroup	37767.173	187	201.963			GR2-GR3

As can be seen in Table 3, as a result of the one-way variance analysis (ANOVA), which was implemented to determine whether there was a significant difference among the post-application overall achievement scores of the students participating the learning process in three different experimental environments, it was determined that there was a statistically significant difference [$F(2,187)=8.334$; $p<.05$]. The effect size (eta squared) calculated as a result of the test was determined as $\eta^2 = 0.08$. This eta-squared value demonstrate that the effect was in "medium" level. In other words, it can be mentioned that the 8% of the observed variance in the *posttest achievement score* dependent variable can be explained by the experimental conditions, and that it depends on the *participation* independent variable. Following this process, the complimentary post-hoc analysis techniques were applied in order to determine the source group of the significant difference detected through the ANOVA (Table 4).

Table 4. *Post-Hoc Scheffe Test results following the one-way variance analysis (ANOVA) that was employed to determine which sub-groups differed according to the posttest achievement scores.*

	Groups	Difference in Means	*p*
GR1-Mandatory	GR3-Non-attendee	8.973*	.002
GR2-Voluntary	GR3-Non-attendee	9.145*	.002

*$p<.01$

As a result of the Post-Hoc Scheffe Test following the one-way variance analysis (ANOVA), which was employed to determine which sub-groups differed according to the posttest achievement scores, it was determined that there was a statistically significant difference (at $p<.01$ level) between the mandatory participants and non-attendee participants in favor of the mandatory participants. Additionally, it was determined that there was a statistically significant difference (at $p<.01$ level) between the voluntary participants and non-attendee participants (Table 4). In line with these findings, it can be stated that the overall achievement levels of the students who participated in the discussions in the discussion-oriented flipped learning environments were significantly higher compared to those who did not participate in the discussions.

The effect size (Cohen's d) obtained from the pretest-posttest mean scores of the students from the mandatory participation group was $d = 1.89$ (large effect). The effect size (Cohen's d) obtained from the pretest-posttest mean scores of the students from the voluntary participation group was $d = 2.18$ (large effect). The effect size (Cohen's d) obtained from the pretest-posttest mean scores of the students from the non-attendee group was calculated as $d = 1.71$ (large effect). Accordingly, it was interpreted that the effect of the participation independent variable on the pretest-posttest achievement mean scores was large effect.

3.2. Findings and Interpretations Concerning the Satisfaction Variable

3.2.1. *Findings concerning video satisfaction scores*

One-way variance analysis (ANOVA) was employed in order to determine whether the video satisfaction mean scores of the students in the groups differ on a group basis. As a conclusion of the analysis, the descriptive statistics concerning the video satisfaction variable comprising of 15 items are given in Table 5.

Table 5. *Mean and standard deviation values of video satisfaction scores of the student groups.*

Groups	*N*	$\bar{X}$	*Sd*	%	Min	Max
GR1 – Mandatory	69	59.29	11.31	79.05	17.00	75.00
GR2 – Voluntary	61	59.43	11.14	79.24	20.00	75.00
GR3 – Non-attendee	60	57.47	12.82	76.62	15.00	73.00
Total	190					

Examining Table 5, it is seen that the video satisfaction mean scores of the students participating in the discussion-oriented flipped learning environment in the mandatory group was $\bar{X}$=59.29 (79.05%), while it was $\bar{X}$=59.43 (79.24%) for those in the voluntary group. The video satisfaction mean scores of the students in the non-attendee group was $\bar{X}$=57.47 (76.625). The results of the one-way variance analysis (ANOVA) which was implemented to determine whether there was a significant difference among the video satisfaction mean scores of the students participating in the learning process in three different experimental environments are given in Table 6.

Table 6. *One-way variance analysis (ANOVA) of the video satisfaction scores of the students in the groups.*

Variance Source	Sum of Squares	*Sd*	Mean of Squares	F	*p*
Intergroup	146.809	2	73.404	.531	.589
Intragroup	25848.054	187	138.225		

As a result of the one-way variance analysis (ANOVA) which was implemented to determine whether there was a significant difference among the video satisfaction scores of the students participating in the learning process in three different experimental environments, it was determined that there was statistically no significant difference [F(2,187)=0.531, p>.05]. This finding is interpreted that the participation status of the students in the discussion environments did not cause a significant difference in the video satisfaction mean scores.

3.2.2. *Findings concerning the discussion satisfaction scores*

The results of the t-test which was employed in order to determine whether there was a significant difference among the discussion satisfaction levels of the students participating in discussions in two different experimental environments in the flipped learning environment are presented in Table 7.

Table 7. *Mean and standard deviation values of the student groups concerning their discussion satisfaction levels.*

Groups	*N*	$\bar{X}$	SS	%	Min	Max
GR1 – Mandatory	69	37.99	10.29	75.98	10.00	50.00
GR2 – Voluntary	61	33.75	9.83	67.50	11.00	50.00
Total	130					

In line with the data obtained from the discussion satisfaction scale, which was comprised of 10 items, it was determined that the discussion satisfaction level of the students participating in the discussions on a mandatory basis was $\bar{X}$=37.99 (75.98%), which was higher compared to $\bar{X}$=33.75 (67.50%), the mean score of those participated on a voluntary basis (Table 7). Paired sample t-test analysis was conducted in order to determine whether this difference was significant (Table 8).

Table 8. *t-test analysis results of the discussion satisfaction scores of the student groups.*

Participation Status	*N*	$\bar{X}$	*Sd*	*Sd*	*t*	*p*
GR1- Mandatory	69	37.99	10.291	128	2.390	.018
GR2- Voluntary	61	33.75	9.825			

Examining the *t*-test analysis results concerning the discussion satisfaction scores of the students in the groups (Table 8), it was determined that there was a statistically significant difference between the discussion satisfaction levels of students from the mandatory group and students from the voluntary group [t(128)=2.390, p<.05]. Accordingly, the discussion satisfaction levels of the students from the mandatory group were higher compared to those of the students in the voluntary group. In line with the results of the *t*-test, the effect size (eta squared) was calculated as $\eta^2 = 0.04$. Based on this effect size, it was interpreted that mandatory or voluntary participation status of students had a “low level” effect size on the discussion satisfaction scores.

3.3. Findings and Interpretations Concerning the High-Ordered Thinking Skills Variable

Descriptive statistics concerning the one-way variance analysis (ANOVA) results, which was used in order to determine whether there was a statistically significant difference in the high-ordered thinking skills of students participating in the learning process in three different experimental environments, are given in Table 9.

Table 9. *Mean and standard deviation values of student groups concerning the high-ordered thinking skill pretest-posttest scores.*

Groups	*N*	Pretest		Posttest	
		$\bar{X}$	*Sd*	$\bar{X}$	*Sd*
GR1 – Mandatory	69	2.78	6.51	27.71	17.81
GR2 – Voluntary	61	2.55	5.36	29.44	17.69
GR3 – Non-attendee	60	2.80	7.80	13.00	14.21
Total	190				

Examining Table 9 and as a result of the evaluation concerning the high-ordered thinking skills pretest and posttest scores, it can be stated that there is a general increase in the high-ordered thinking skill scores of all the students. As a result of the one-way variance analysis (ANOVA), which was employed to determine whether there was a statistically significant difference among the high-ordered thinking skill pre-application scores of students participating in the learning process in three different environments, it was determined that there was statistically no significant difference [$F(2,187)=0.026$; $p>.05$]. The results of the one-way variance analysis (ANOVA), which was employed to determine whether there was a statistically significant difference among the high-ordered thinking skill post-application scores of students participating in the learning process in three different environments, are given in Table 10.

Table 10. *One-way variance analysis (ANOVA) concerning the high-ordered thinking skill posttest scores of student groups.*

Source of the Variance	Sum of Squares	*Sd*	Mean of Squares	F	*p*	Significant Difference
Intergroup	9989.464	2	4994.732	17.863	.000	GR1-GR3
Intragroup	52287.252	187	279.611			GR2-GR3

As can be seen in Table 10, one-way variance analysis (ANOVA) was implemented in order to determine whether there was a significant difference among the post-application scores in high-ordered thinking skills of the students participating in the learning process in three different experimental environments. As a result of the analysis, it was determined that there was a statistically significant difference between the high-ordered thinking skills of students [$F(2,187)=17.863$; $p<.05$]. The effect size calculated after the test was $\eta^2 = 0.16$. This eta-squared figure demonstrated that there was a large effect. Subsequent to this process, the complimentary post-hoc analysis methods were implemented in order to determine the source group of the difference (Table 11).

Table 11. *Post-hoc Scheffe test results following the one-way variance analysis (ANOVA) that was employed to determine which sub-groups differed according to the high-ordered skill posttest scores.*

Group		Differences in Means	*p*
Mandatory	Non-attendee	14.710*	.000
Voluntary	Non-attendee	16.442*	.000

*$p<.01$

According to Table 11, as a result of the Post-Hoc Scheffe Test following the one-way variance analysis (ANOVA) which was employed to determine which sub-groups differed according to the high-ordered thinking skill scores, it was determined that there was a statistically significant difference (at $p<.01$ level) between the mandatory participants and non-attendee participants in favor of the mandatory participants. Additionally, it was determined that there was a statistically significant difference (at $p<.01$ level) between the voluntary participants and non-attendee participants (Table 11). In line with these findings, it can be stated that participation in discussions in the flipped learning environments regardless of participating mandatorily or voluntarily, have a positive influence on the high-ordered thinking skills.

4. DISCUSSION and CONCLUSION

In this semi-experimental research, the impacts of participation status of students in the discussions in a discussion-oriented flipped learning environment on their achievement, satisfaction and high-ordered thinking skills were examined. The results obtained from the findings based on the experimental processes are listed below.

There is a significant difference among the pretest-posttest achievement scores of all student groups (mandatory, voluntary, non-attendee), who had a six-week learning experience in a discussion-oriented flipped learning environment. In other words, it can be mentioned that learning was experienced in all groups.

Comparing the overall achievement scores of the students based on their participation status in the discussions in the flipped learning environment, it was determined that the achievement levels of the students who mandatorily or voluntarily participated in the discussions compared to the non-attendees. According to this finding, it can be stated that turning the flipped learning environments into discussion-oriented environments will increase the achievement levels of students. Using discussions in flipped learning environments influences the learner interactions, and it can influence the achievement performances in a positive way. Zainuddin (2018) reported that using discussion environments in the flipped learning environments influenced the interactions of the learner in a positive way, which in turn, increased the achievement and satisfaction levels. Lack of interaction in flipped learning, which was the starting point of this study, was tried to be eliminated through a discussion environment that was integrated into flipped learning process. Thus, it can be stated that turning the flipped learning process into a discussion-oriented environment can provide an enhancement in the learner achievement level. There was no significant difference between the video satisfaction levels of the student groups participating in the flipped learning environment. Accordingly, when the video satisfaction mean scores of students are examined, it can be said that students who watch videos in a flipped learning environment are generally satisfied with the videos. Based on the fact that there was statistically no significant difference among the groups concerning the video satisfaction levels, it can be suggested to be emerging from that all groups were provided with the same video material.

A statistically significant difference was determined between the mandatory and voluntary participant groups in the discussions of the flipped learning environment, in favor of the mandatory participants. Accordingly, it can be stated that making it mandatory for the students to participate in discussions in the flipped learning environment can increase their discussion satisfaction levels.

It was determined that there was statistically no significant difference among the general environment satisfaction levels of the participant student groups in the flipped learning environment. Though not significant, the general environment satisfaction level of the students mandatorily participating in the discussions was higher compared to the other groups. Based on this finding, it can be stated that students in all groups were satisfied with the general

environment. Davies et al. (2013) emphasized that flipped learning environment increased the satisfaction levels of students, which in turn had a positive impact on the achievement levels of the learner. In this study, the flipped learning method was applied to the three groups of students. Having a positive satisfaction level in all groups is a finding that is in parallel to those of similar studies in the literature.

While there was no difference among the high-ordered thinking skill pretest mean scores of the student groups participating in the flipped learning environment, it was determined that there was a significant difference among the high-ordered thinking skill posttest mean scores of the groups after the application. Accordingly, it was determined that at the end of the six-week application, the high-ordered thinking skill scores of the students who participated in the discussions regardless of participating mandatorily or voluntarily were significantly higher compared to those not participating in the discussions. It can be stated that regardless of voluntarily or mandatorily, participation in the discussions in a flipped learning environment has a positive impact on the high-ordered thinking skill levels compared to that of non-participation. Online discussion environments are the medium where students can practice their high-ordered thinking skills. As a conclusion of this study, it is considered that using the discussion environment has a positive impact on the development of high-ordered thinking skills of students.

In this research study, it was concluded that using a discussion platform in the flipped learning environment increases the achievement level of the learner. Based on this finding, it can be stated that the developers who will use the flipped learning method and prepare a flipped learning environment can create a more efficient teaching-learning environment by using the discussion environments together with the course videos.

In this quasi-experimental study, there is a limitation due to the pre-test and post-tests administered at six-week intervals. This situation, which is one of the weaknesses of the research, could not be controlled. It is recommended that subsequent investigators perform similar studies over a larger time period with a completely random sample distribution.

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Declaration of Conflicting Interests and Ethics

The authors declare no conflict of interest. This research study complies with research publishing ethics. The scientific and legal responsibility for manuscripts published in IJATE belongs to the authors. Ethics Committee Number: Ankara University/Social and Humanities Ethics Committee, 2019-11/344.

Authorship Contribution Statement

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