Hacettepe University Journal of Education

Hacettepe Üniversitesi Eğitim Fakültesi Dergisi

e-ISSN: 2536-4758

Dönüştürülmüş Sınıf ve Revize Edilmiş Dönüştürülmüş Sınıf Modellerinin Akademik Başarı ve Planlama Becerisine Etkisinin Karşılaştırılması*

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Makale Bilgisi

Geliş Tarihi: 20.11.2021

Kabul Tarihi: 27.01.2021

Erken Görünüm Tarihi: 29.01.2021

Basım Tarihi: 30.04.2022

ÖZET

Araştırmanın amacı dönüştürülmüş sınıf modeline dayalı uygulamaların ilkokul 4. sınıf öğrencilerinin akademik başarı düzeyi ve planlama becerileri üzerindeki etkisini araştırmaktır. Örneklem Samsun'da devlet okulunda öğrenim gören 60 ilkokul 4. sınıf öğrencisinden oluşmaktadır. Araştırma nicel verilerin nitel verilerle desteklendiği açımlayıcı karma desende, nicel boyutu 3x2'lik ön test- son test kontrol gruplu yarı deneysel desende tasarlanmıştır. Araştırma her grupta 20 öğrenci olmak üzere 4 hafta boyunca dönüştürülmüş sınıf modelinin uygulandığı deney 1, revize edilmiş dönüştürülmüş sınıf modelinin uygulandığı deney 2 ve yürürlükte olan MEB ders ve çalışma kitabındaki etkinliklerin uygulandığı kontrol grubundan oluşmaktadır. Veriler, Fen Bilimleri ve Sosyal Bilgiler Kazanım Değerlendirme testleri ve Londra Kulesi Testi 4 ile toplanmıştır. Akademik başarı ve planlama becerisi düzeylerindeki değişimlerin karşılaştırılması için tekrarlı ölçümler için karışık desen ANOVA testine başvurulmuştur. Araştırma sonuçları dönüştürülmüş sınıf modeline dayalı uygulamaların akademik başarı üzerinde anlamlı bir şekilde daha etkili olduğunu göstermektedir. Dönüştürülmüş sınıf modeli ile revize edilmiş dönüştürülmüş sınıf modelinin uygulandığı gruplar arasında akademik başarı düzeyi açısından anlamlı bir farklılık olmadığı sonucuna ulaşılmıştır. Planlama becerisi düzeyleri açısından ise gruplar arasında anlamlı farklılığın olmadığı tespit edilmiştir. Dönüştürülmüş sınıf modelinin uygulandığı gruplarda yer alan öğrenciler modele ve animasyonlara, kare koda dayalı etkinliklere ilişkin olumlu görüş bildirdirmişlerdir. Her iki modelinde akademik başarı üzerinde etkili olduğu sonucundan hareketle, okullarda yaygın bir şekilde kullanımı önerilmektedir. Çevrimiçi sınıf yönetimi platformlarının kullanıldığı araştırmalarda modelin akademik başarı ve planlama becerisi üzerindeki etkisi araştırılabilir.

Keywords: Dönüştürülmüş sınıf modeli, revize edilmiş dönüştürülmüş sınıf modeli, akademik başarı, planlama becerisi, ilkokul

Comparison Effects of Flipped and In-Class Flipped Classroom Models on Academic Achievement and Planning Skills

Article Information

Received: 20.11.2021

Accepted: 27.01.2021

Online First: 29.01.2021

Published: 30.04.2022

ABSTRACT

The purpose of this study is to investigate the effect of applications based on the flipped classroom model on the academic achievement and planning skills of primary school fourth-grade students. The study sample consisted of 60 fourth grade students who attend a state primary school in Samsun. This study employed a mixed sequential explanatory design integrating quantitative and qualitative research methods. The study's quantitative dimension was designed as a semi-experimental design with a 3x2 pre-test and post-test control group. The study group consisted of 20 students in each group, experimental 1 received flipped classroom model-based science and social studies class, experimental 2 received in-class flipped classroom model-based science and social studies class, and the control group received the same classes specified by teacher and student books published in 2014 for four weeks. Research data was obtained with data tools developed within the research that Science and Social Studies courses learning outcome assessment tests, and the Tower of London Test. Mixed design repeated-measures ANOVA was used to compare students' academic achievement and planning skill levels. Research results show that each application in a flipped classroom was more effective than a traditional course on Science and Social Studies academic achievement. However, there was no significant difference between academic achievement levels of students in groups trained by flipped and in-class flipped classrooms. Research results show no significant difference between the students' planning skill levels in groups. Research results obtained by qualitative data show that students in groups who received

* This study was produced from the PhD thesis titled "Effect of applications based on flipped classroom on academic achievement and planning skills of 4th grade primary school students" conducted by Elif GÜVEN DEMİR under the supervision of Yücel ÖKSÜZ at Ondokuz Mayıs University. This study was approved by Ondokuz Mayıs University Social and Humanities Ethics Committee (approval no. 2016-97).

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flipped classroom models had a positive opinion on the flipped classroom, animations, and QR code activities. Both flipped classroom models are recommended for use in schools extensively; based on the research results, both models were effective on academic achievement. Future studies should recruit a sample with access to online classroom management platforms at home to examine the effect of model on academic achievement and planning skills.

Keywords: Flipped classroom, in-class flipped classroom, academic achievement, planning skill, primary school

doi: 10.16986/HUJE.2021067072 Makale Türü (Article Type): Research Article

Kaynakça Gösterimi: Güven Demir, E., & Öksüz, Y. (2022). Dönüştürülmüş sınıf ve revize edilmiş dönüştürülmüş sınıf modellerinin akademik başarı ve planlama becerisine etkisinin karşılaştırılması. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 37*(2), 523-540. doi: 10.16986/HUJE.2021067072

Citation Information: Güven Demir, E., & Öksüz, Y. (2022). Comparison effects of flipped and in-class flipped classroom models on academic achievement and planning skills. *Hacettepe University Journal of Education, 37*(2), 523-540. doi: 10.16986/HUJE.2021067072

1. INTRODUCTION

A flipped classroom is a type of blended learning in which students learn content by watching videos at home and learn actively by discussing complex concepts and answering content-related questions in class (Stone, 2012). The primary objective of the FCM is to devote more time to in-class activities to provide active learning (Haak, HilleRisLambers, Pitre & Freeman, 2011). Active learning involves skill development rather than the passive transmission of information and promotes critical thinking, analysis, synthesis and evaluation, and exploration of attitudes and values (Bonwell & Eison, 1991).

The FCM consists of three stages; in-class, pre-class, and post-class. There is a difference in pre-class and in-class responsibilities between flipped and traditional classroom models. In the traditional classroom, in-class activities target knowledge acquisition, while the pre-class stage focuses on homework to practice new knowledge. The FCM sees homework as an in-class activity (Ojennus, 2016). In the FCM, students spend their pre-class time on content-related materials and activities to acquire basic knowledge and prepare for in-class learning (McLaughlin, White, Khanova & Yuriev, 2016; Persky & McLaughlin, 2017). Pre-class content targets key points that promote critical thinking and deep in-class learning (McLaughlin et al., 2016).

The in-class stage of the FCM is devoted to active learning activities without having to transmit new knowledge (O'Connor, Mortimer & Bond, 2011). Active learning requires students to have the basic content knowledge and pick out key points by watching videos before class (Davis & Minifie, 2013; DeLozier & Rhodes, 2017), which allows them to devote valuable in-class time to teacher-guided problem-solving and group activities (Bergmann & Sams, 2012).

The post-class is the third stage of the FCM. Students can evaluate themselves after class by watching the pre-class videos and taking the pre-class tests in the classroom management platform again (Gariou-Papalexiou, Papadakis, Manousou & Georgiadu, 2017). They can rewatch the videos on the topics they think they need to review (Estes, Ingram & Liu, 2014). Flipped classroom teachers can keep their students motivated and evaluate their performance (Estes et al., 2014). In other words, the post-class stage turns the teacher from an instructor to a learning coach who helps students develop self-regulation strategies (Talbert, 2014).

Numerous studies investigate the effect of the FCM on academic achievement and meta-analyses show that FCM have a positive effect on student achievement (Bhagat, Chang & Chang, 2016; Chao, Chen & Chuang, 2015; Clark, 2015; DeSantis, Van Curen, Putsch & Metzger, 2015; Kirvan, Rakes & Zamora, 2015; Lai ve Hwang, 2016; Lee & Wallace, 2018; Overmyer, 2014, Peterson, 2016; Schultz et al., 2014; Smith, 2015; Strelan, Osborn & Palmer, 2020; Özüdoğru & Aksu, 2020; Zheng, Bhagat, Zhen, Zhang,2020). Although they report different results, they all agree that the key components of the FCM should be identified to make it an effective alternative to traditional teaching methods, and there are still key questions needed to answer are, what is the important ingredient in the flipped classroom recipe and how does it contribute to the effectiveness of the flipped classroom (Strelan, Osborn & Palmer, 2020).

At this point, it is thought that research results on the application of flipped classrooms in different conditions are needed. In other words, research results on the applicability of the model are also required for students who do not have a computer or internet connection at home or who do not have the habit of working alone. From this point of view, this study has been done in which flipped, in-class flipped, and traditional classroom models are compared.

González (2014) was the first to talk about the in-class flipped classroom model (IC-FCM) to overcome the challenges faced by traditional flipped classroom teachers, such as students not having computers or tablets and Internet access or not watching the assigned videos before class. The only difference between the FCM and IC-FCM is that students watch videos at home in the former and at school in the latter (Brown, 2016). The IC-FCM is a viable alternative because it allows students with no computers/tablets and Internet access to watch videos during class (Zupon, 2017). Barnes and Gonzalez (2015) define the IC-FCM as a model that moves the pre-class stage of the FCM to the classroom and allows students to access course content in one station while practicing in others. IC-FCM students can watch course videos in classroom stations (Brown, 2016) and visit stations one by one to achieve essential learning and to put what they have learned from videos into practice (Zupon, 2017). The greatest advantage of the IC-FCM is that it allows teachers to monitor students and evaluate their performance in the stations (Ramirez, 2018). However, students do not necessarily have to visit the stations to put theory into practice (Ramirez, 2018). Brown (2016) argues that the IC-FCM is more effective than the FCM because FCM students, especially younger ones, may perceive pre-class video assignments as homework and feel less motivated to learn. The IC-FCM is superior to the FCM because it allows students from disadvantaged backgrounds to access technological devices and the Internet. IC-FCM teachers can integrate all educational components into the lecture and control their teaching (Brown, 2016).

Few studies address different types of FCMs (Fryling, Yoder, & Breimer,2016) and either discuss their effectiveness individually or compare them with the traditional classroom model (Ahmed, 2020; Fauzi, 2020; Grimaldos Urrea, 2020; Lax, Morris, & Kolber, 2017). On the other hand, this study compared two types of FCMs and evaluated their effects on the education of students without Internet access and computers. There are different results about the impact of the learning domain on the effectiveness of the flipped classroom (Cheng, Ritzhaupt & Antonenko, 2019; Zheng et al. 2020). The study focused on the effectiveness of the FCM and IC-FCM in science and social studies classes of primary school fourth-grade students test whether the models were suitable for different courses and younger students.

The study took into account the literature findings on and criticisms against the FCM to design pre-class materials and in-class activities (Bormann, 2014; Sota, 2016). Shi, Ma, Macleod & Yang (2020) state that the flipped classroom is more effective when instructors integrate individualized active and collaborative pedagogical approaches. The study developed all the stages of the model with active learning approach. Research results show that watching videos in pre-class stage has large effect size on FCM (Zheng et al., 2020). The pre-class materials were designed as age-appropriate animations. The in-class activities were animations and QR code based problem solving activities that appealed to digital natives. Animation-based tests were used to measure and evaluate the effectiveness of the models. The study was designed in a way to ensure the effective use of technology. By examining the students' experiences about different aspects of the study, such as using animation, QR codes, and in-class flipped model, new variables related to the flipped classroom model's effectiveness were tried to be revealed.

The FCM focuses on 21st-century skills and encourages students to perform basic learning individually and deep learning collectively (Selvabarathi & Govindarajan, 2016). A society with a culture of learning allows its members to have responsibility for and control over their own learning (Niemi, 2002). Planning the learning process has become critical components of the new educational perspective enabling learners to take responsibility for their own learning, especially during the Covid-19 pandemic. Besides, FCM requires students' active participation and puts to work planning skills with interconnected stages.

Planning skills are crucial executive and functional skills, and defined as a manifestation of behavioral or cognitive management to achieve goals (Tunstall, 1999). People start developing planning skills early and continue to do so until young adulthood (Less, 2008). Acquiring planning skills is a critical stage of development (McCormack & Atance, 2011). They play a critical role in different areas of social and cognitive development and help students manage school-related tasks and strike a balance between activities (Blair, 2002). Planning is also a metacognitive process involved in problem-solving and decision-making (Mahapatra, 2016).

Children with planning skills are more likely to develop linguistic, literacy, social, and other developmental skills (Epstein, 1993). Students who can make and execute plans and review new knowledge are likely to have more goal-directed behavior and perform in language and mental areas better (Dağlıoğlu & Çakır, 2010). According to Mahapatra (2016), 3-7 and 11-12 are critical ages for developing planning skills promoted by educational systems and methods.

Childhood, and thus, primary school, is critical for the development of planning skills. Learning environments where teachers are the provider of knowledge, and students are passive recipients of knowledge are not conducive to the development of planning skills. Previous studies on the FCM focus on the pre-class and in-class stages and overlook the post-class stage. However, this study focused on the post-class stage to help students develop planning skills.

The pre-class, in-class, and post-class stages of the FCM allow students to actively participate in and take responsibility for their learning and develop planning skills. FCM students can decide when and how many times to watch videos and when to take tests before class (pre-class stage) and take responsibility for and evaluate their own learning and make new plans to fill their potential gaps of knowledge after class (post-class stage). FCM students who go through the three interconnected stages can take more responsibility for their own improvement and learning and have better academic achievement and planning skills. In this study, the objective of the in-class QR code activities was to address students' ability to plan their learning and follow instructions. In other words, the FCM was the model of choice to help students develop planning skills.

2. METHOD

2.1. Research Model and Design

This study employed a mixed sequential explanatory design integrating quantitative and qualitative research methods to determine the effect of FCM activities on primary school fourth-grade students' academic achievement and planning skills. The sample was divided into three groups: experimental 1, experimental 2, and control. Experimental group 1 received FCM-based science and social studies class. Experimental group 2 received IC-FCM-based science and social studies classes. The control group received science course teaching (SciCT) and social studies course teaching (SocCT) specified by teacher and student books published in 2014. Before the experiments, all groups took the science course learning outcome assessment test (SciLO), social studies course learning outcome assessment test (SocLO), and the four-disc version of the Tower of London (TLT4).

In order to increase internal reliability, studies were included in the titles of the selection of participants, data collection tools, the background of participants.

The Selection of Participants: It was learned from the school administration that no criteria were taken into account when determining the branches. The students have randomly created branches in the first grade and were in the same branches until the 4th grade. It can be said that the study group, which was determined in alphabetical order, did not have an element that would threaten the internal validity since it was determined that there was no bias in determining the branches in which the students took part.

Maturation of the Participants: The fact that the study was conducted for four weeks reduces the possibility that the changes due to the students' mental maturation in the research group will affect the result of the study. Besides, the control group's presence in the study provides an advantage in controlling the possible alternative maturation effect.

Data Collection Tools: The data collection tools remained unchanged during the research, and the application and data collection process were carried out by the researcher herself in all groups. In data collection tools with partial scoring, student responses were scored by two raters using a rubric.

Background of the Participants: Apart from the experimental procedures, no concrete event or situation that could cause changes in the dependent variables was determined during the research.

2.2. Sample

Power analysis was performed to determine the minimum number of participants necessary to detect significant differences. The result showed that a sample size of 46 would be sufficient (power of 95%, = 0.05, the effect size = 0.60). The study sample consisted of 60 (girl:35, boy:25) fourth-grade primary school students aged 9-19 years in Samsun/Turkey in 2016-2017. Students were recruited to the quantitative and qualitative stages using multistage sampling. The experimental school was selected among the primary schools in Samsun using multistage sampling. First, primary schools with an “E-Library” (enriched library) were identified, and then, the experimental school was randomly selected among them. First, grade levels were identified using systematic sampling. One of the schools had seven fourth-grade classrooms. Three classrooms ranked alphabetically by the school administration were included in the study. The study groups took the pretests two weeks before the procedure to determine the equivalence of groups assigned by the school administration. A simple probabilistic (random) sampling was used to draw the experimental and control groups from classrooms with similar pretest scores. Experimental 1, experimental 2, and control groups were drawn from the three classrooms where the school administration gave research consent.

Multivariate analysis of variance (MANOVA) was used to compare the SciLO and SocLO pretest scores to determine whether the groups were equivalent before the procedure in terms of dependent variables. Their TLT4 pretest scores were compared using independent samples one-way analysis of variance (ANOVA). Their SciLO and SocLO pretest scores did not differ significantly by group variable ($F(4,112)=.307$, $p>.05$, Wilk's ?=.978), indicating equivalence. Their TLT4 pretest scores did not differ significantly by group variable ($F(2,57)=.278$, $p>.05$), indicating equivalence.

Students were recruited to the qualitative stage using sequential mixed method sampling. The quantitative analysis showed no difference in academic performance between the experimental groups. Therefore, purposeful sampling was employed, and the experimental groups were included in the qualitative stage. Maximum variation sampling was used to achieve gender and performance (science and social studies courses) diversity. Semi-structured interviews were conducted with four participants with low, medium, and high SciLO and SocLO scores from each experimental group (six girls and six boys; 24 in total).

2.3. Data Collection Tools

Quantitative data were collected using the science course learning outcome assessment test (SciLO), social studies course learning outcome assessment test (SocLO), and the four-disc version of the Tower of London (TLT4). Analytical rubrics were developed to score the SciLO and SocLO tests.

Qualitative data were collected using an “Semi-Structured Interview Form.” The SciLO and SocLO tests and interview forms were developed by the researcher to measure academic achievement. The TLT4 was used to measure planning skills. It was developed by Tunstall (1999) and adapted to Turkish and converted into a computerized version by Güven Demir and Öksüz (2017).

2.3.1. Validity and reliability of SciLO and SocLO

Eighteen-item draft SciLO and 30-item draft SocLO were developed to determine students’ academic achievement. SciLO was based on the learning outcome "This explains the revolution and rotation of the Earth and their consequences" of the unit "Motions of the Earth" of the subject area "Earth and Universe" of the science course. SciLO consisted of open-ended questions with audio and visual animations related to the unit. The animations visualized the revolution and rotation of the earth. The open-ended questions were about the consequences of those phenomena. SciLO consisted of 18 animations and 18 open-ended questions. The animations were created using GoAnimate for Schools. Classical test theory was used to determine the validity and reliability of SciLO. Table 3 shows the analysis results.

SocLO was developed the same way. It consisted of 30 animations and 30 open-ended questions used to determine learning outcomes. It was based on the concepts and learning outcomes of the unit "My Friend Far Away" of the subject area "Global Connections" of the social studies course. Classical test theory was used to determine the validity and reliability of SocLO. Table 1 shows the analysis results.

Table 1.
Validity and Reliability of SciLO and SocLO

			SocLO	SciLO
Validity	Content validity Index		0.96	0.93
	Item difficulty Index		0.54	0.56
	Item discrimination Index		0.43	0.45
Reliability	Internal Consistency		0.817	0.758
	Equivalent Halves		0.827	0.752
	Parallel Forms		0.813	0.837
	Interrater Agreement	Pearson Correlation Coefficient	0.948	0.959
		Krippendorff's alpha	0.947	0.959
Final Number of Items			27	16

The results showed that SciLO and SocLO were valid and reliable measurement instruments. They consisted of animation-based open-ended questions, and therefore, rubrics were developed scored on a 2-point Likert-type scale (2= Totally True, 1= Partly True, and 0= Wrong). Experts were consulted, and content validity indices were calculated to determine the validity of the rubrics. The rubrics for SciLO had a content validity index of .955. Inter-rater results indicating high reliability for SciLO were used as a reference for reliability (Pearson Correlation Coefficient, $r=0.959$; Krippendorff's alpha coefficient, $\alpha=0.959$). The validity and reliability of SocLO were established the same way. The rubrics for SocLO had a content validity index of .889, Pearson Correlation Coefficient of 0.94, and Krippendorff's Alpha coefficient of 0.947.

2.3.2. The Four-disc version of the Tower of London (TLT4)

Planning skills were measured using the TLT4. Shallice developed the original three-disc version of the Tower of London test (1982), inspired by the Hanoi test within artificial intelligence research. Tunstall (1999) increased the item difficulty of the original test and developed the TLT4 for individuals aged 5-53 years who were sensitive to color blindness. Güven Demir and Öksüz (2017) adapted the TLT4 to Turkish and converted it into a computerized version, which was used in this study. The TLT4 asks the participant to complete ten target puzzles of varying difficulty levels in the fewest moves.

Tunstall (1999) and Güven Demir and Öksüz (2017) reported that the TLT4 had satisfactory item difficulty and discrimination and acceptable reliability. This study tested the validity and reliability of the TLT4 again. The item analysis showed that the TLT4 had moderate difficulty and sound discrimination. It had a Cronbach's alpha (internal consistency coefficient) of 0.66 and a split-half reliability coefficient of 0.64.

2.3.3. Semi-structured interview form

Participants were interviewed using a semi-structured interview form. Experimental 1 participants were asked, "What if you watched the animations at school, but not at home?" Experimental 2 participants were asked, "What if you watched the animations at home, but not at school?" Apart from these two questions, both groups were asked the same questions. The form was finalized based on expert feedback. The interviews were conducted within the framework of the questions in this form. Interviews were recorded by asking for student approval.

2.4. Experiments

The study was conducted in May in the 2016-2017 academic year. The experiments were based on the current course schedules and conducted within the scope of the unit "Motions of the Earth" of the subject area "Earth and Universe" of the science course and the unit "My Friend Far Away" of the subject area "Global Connections" of the social studies course. Experimental group 1 received FCM-based science and social studies classes. Experimental group 2 received IC-FCM-based the science and social studies classes. The control group performed the activities in the science and social studies guidebooks recommended by the Turkish Ministry of Education. The experiments were conducted three days a week (Monday - control group; Tuesday -

Experimental 2; and Wednesday - Experimental 1) for four weeks, six classes per week (three hours of science; three hours of social studies).

The researcher developed animations to convey the course content to the experimental groups (see Figure 1 and Figure 2). Experimental 1 participants were asked to watch the videos and immediately take the content-related test and bring them to the school. Participants with a computer at home were given removable memories containing the course content. Those without a computer at home were given a tablet with the course content in it.

Figure 1. Sample scenes from animations used in Science class

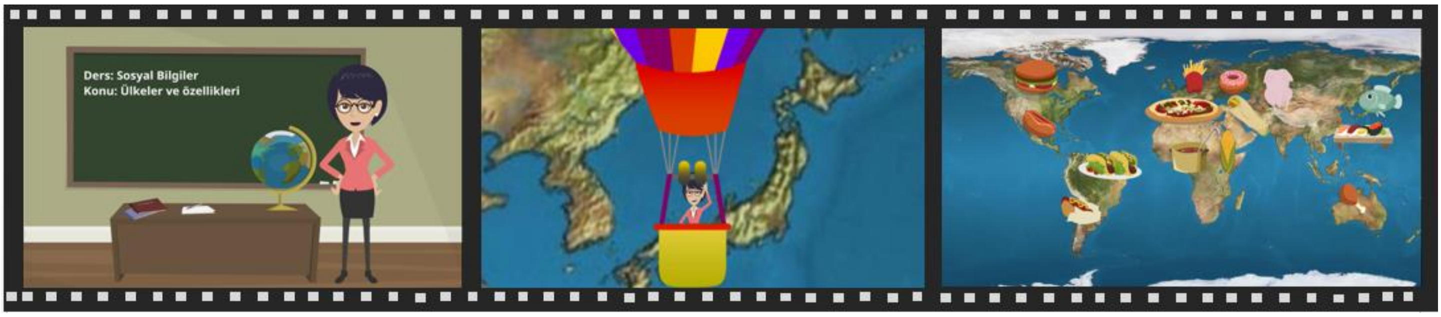

Figure 2. Sample scenes from animations used in Social Studies class

In the first class, the researcher summarized the vague parts of the animations and moved on to activities stimulating high-level thinking skills. Different from the control group, experimental groups went through the post-class stage. Participants were asked to keep a learning diary (right after each class) about their pre-class and in-class experiences and performance.

Experimental group 2 received the same content and activities as experimental group 1. However, experimental 2 participants watched the course videos with their classmates at school. In the first class, they watched the animations on their tablets with their headphones on and then completed the tests. They were asked to watch the animations again. In the remaining time, the researcher analyzed their tests, identified the unintelligible parts, and briefly explained them.

The in-class activities were QR code based problem solving activities and activities that encouraged participants to acquire new knowledge and construct existing knowledge. The purpose of the QR code activities integrated with puzzles was to activate students' ability to find and use information. The researcher developed the QR code activities and puzzles. The QR code activities were arranged (with an algorithm) to activate students' higher-order thinking skills. They contained information and hints and passwords to arouse students' curiosity and keep them motivated. The control group performed the activities in the teacher's guidebook and textbooks.

2.5. The Role of Researcher

The researcher conducted the study activities, who was an active participant and facilitator of the lessons. The researcher applied all the activities that she developed and collected the data by herself. To not affect student expectations, the information that data was collected for scientific research was not shared with students. Since the students were not known before, there was no bias due to familiarity.

2.6. Data Analysis

2.6.1. Quantitative data analysis

The equivalence of SciLO and SocLO pretest scores was determined using MANOVA, which is a Type 1 error-free statistical analysis used to analyze the relationship between dependent variables. The equivalence of the TLT4 pretest scores was determined using the one-way ANOVA test. Levene's test was used to test the homogeneity of variances of the One-way ANOVA test.

Mixed design repeated-measures ANOVA was used to compare the SciLO, SocLO, and TLT4 pretest and posttest scores. To determine the source of difference, pairwise group comparisons were conducted using Tukey's and Bonferroni tests, which keep Type I error under control (Field, 2009). Tukey's HSD test was used in the ANOVA test because the assumptions of homogeneity of variance and equal-sized groups were satisfied (Tukey, 1949; as cited in Kayri, 2009).

The effect size was used to determine the effects of the FCM and IC-FCM on students' achievement in science and social studies classes. Effect size, which is defined as the size of difference between groups (Sullivan & Feinn, 2012), was used to interpret the relative effects of the FCM and IC-FCM on students' achievement in science and social studies classes. A dependent group t-test was used to compare the pretest and posttest scores for each course. Eta squared effect sizes were calculated and used to determine what percent of the observed variance in science and social studies classes was explained by the FCM and IC-FCM, pointing to the effectiveness of the models depending on the course.

2.6.2. Qualitative data analysis

The semi-structured interview data were analyzed using inductive content analysis based on explanations in the literature. Codes and themes were developed to determine students' experiences, views, and behavior. The codes and themes were analyzed using NVIVO 12.

3. FINDINGS

3.1. Comparison of SciLO Academic Achievement of Groups

Table 2.
Descriptive Results for SciLO Academic Achievement of Groups

		Pretest		Posttest	
Groups	**N**	**Mean**	**S. Deviation**	**Mean**	**S. Deviation**
Experimental 1	20	8.9	3.1	23.8	6
Experimental 2	20	8.6	3.2	25.7	4.1
Control	20	8.3	2.7	15.3	4.1

All groups had higher SciLO posttest scores and pretest scores. The greatest difference was in Experimental group 2, followed by Experimental 1 and control groups (Table 2). A split-plot ANOVA was used to determine whether the differences were statistically significant. Table 3 shows the results.

Table 3.
Split-Plot ANOVA Results for SciLO Pretest-Posttest Scores

Source of Variance	Sum of Squares	df	Mean Square	F	p	η^2_p
Between groups	1984.438	59				
Group (E1,E2,C)	651.331	2	325.666	13.925	0.000*	0.328
Error	1333.107	57	23.338			
Within Groups	6168.984	60				
Measurement (Pretest-Posttest)	5060.426	1	5060.426	535.888	0.000*	0.904
Group*Measurement	570.303	2	285.152	30.197	0.000*	0.514
Error	538.255	57	9.443			
Total	8153.422	119				

*p< 0.05

The split-plot ANOVA results suggested significant group effect (F(2-57) = 13.925; p<.05, η^2_p= .328), indicating that all groups had significantly different SciLO scores, regardless of pretest and posttest measurements. The group variable accounted for 32% of the observed variance in SciLO scores.

The split-plot ANOVA results also showed that all groups had significantly higher SciLO posttest scores and pretest scores (F(1-57)= 535.888; p<.05, η^2_p=.904), indicating that the FCM and IC-FCM accounted for 90% of the observed variance in SciLO scores.

The split-plot ANOVA (Group*Measurement) analysis showed a statistically significant difference between SciLO pretest and posttest scores across the groups (F(2-57)=30.197, p<.05, η^2_p=.514). This result suggested that all groups had significantly higher SciLO posttest than pretest scores, confirming the main hypothesis on academic achievement in the science course. Moreover, the FCM and IC-FCM accounted for 51% of the observed variance in SciLO scores. Tukey's HSD test was used to determine the source of difference regarding the common effect. There was no significant mean difference in SciLO scores between the experimental groups (p>.05). However, there was a significant mean difference in SciLO scores between the experimental and control groups (p<.05). Figure 3 shows within-group variations in the SciLO pretest and posttest scores.

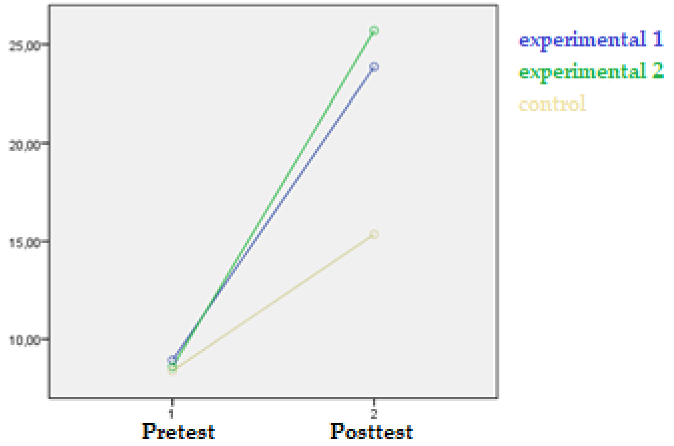

Figure 3. Within-group variations in SciLO pretest and posttest scores

The FCM and IC-FCM increased students' SciLO scores. The greatest increase was observed in Experimental group 2, while the smallest increase was observed in the control group (Figure 3).

3.2. Comparison of SocLO Academic Achievement of Groups

Table 4.
Descriptive Results for SocLO Academic Achievement of Groups

		Pretest		Posttest	
Groups	**N**	**Mean**	**SD**	**Mean**	**SD**
Experimental 1	20	20.2	6.3	43.1	7
Experimental 2	20	21	9.4	41.8	8.5
Control	20	20.8	8.3	29.2	8

All groups had higher SocLO posttest scores and pretest scores. The greatest difference was in Experimental group 1, followed by Experimental 2 and control groups (Table 4). A split-plot ANOVA was used to determine whether the differences were statistically significant. Table 5 shows the results.

Table 5.
Split-Plot ANOVA Results for SocLO Pretest-Posttest Scores

Source of Variance	**Sum of Squares**	**df**	**Mean Square**	**F**	**p**	η^2_p
Between groups	7528.046	59				
Group (E1,E2,C)	1122.031	2	561.015	4.992	0.010*	0.149
Error	6406.015	57	112.386			
Within Groups	11235.403	60				
Measurement (Pretest-Posttest)	9049.770	1	9049.770	542.715	0.000*	0.905
Group*Measurement	1235.158	2	617.579	37.036	0.000*	0.565
Error	950.475	57	16.675			
Total	18763.449	119				

*p< 0.05

The split-plot ANOVA results suggested a significant group effect ($F(2-57)= 4.992; p<.05, \eta^2_p=.149$), indicating that all groups had significantly different SocLO scores, regardless of pretest and posttest measurements. The group variable accounted for 14% of the observed variance in SocLO scores (Table 5).

The split-plot ANOVA results also showed that all groups had significantly higher SocLO posttest than pretest scores ($F(1-57)= 542.715; p<.05, \eta^2_p=.905$), indicating that the FCM and IC-FCM accounted for 90% of the observed variance in SocLO scores.

The split-plot ANOVA (Group*Measurement) analysis showed a statistically significant difference between pretest and posttest SocLO scores across the groups ($F(2-57)=37.036, p<.05, \eta^2_p=.565$). This result suggested that all groups had significantly higher SocLO posttest than pretest scores, confirming the main hypothesis on academic achievement in the social studies course. Moreover, the FCM and IC-FCM accounted for 56% of the observed variance in SocLO scores. Tukey's HSD test was used to determine the source of difference regarding common effect.

There was no significant mean difference in SocLO scores between the experimental groups (p>.05). However, there was a significant mean difference in SocLO scores between the experimental and control groups (p<.05). Figure 4 shows within-group variations in SocLO pretest and posttest scores.

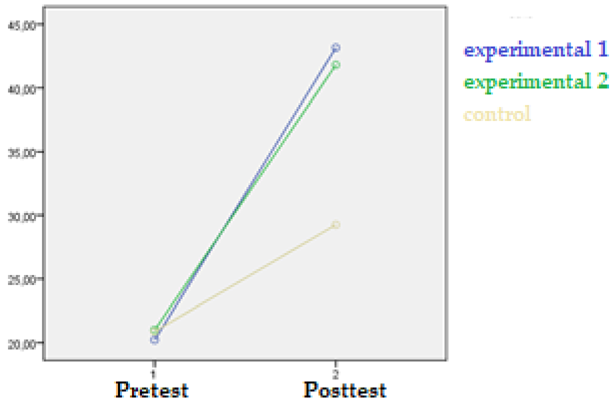

Figure 4. Within-group variations in SocLO pretest and posttest scores

The FCM and IC-FCM increased students' SocLO scores. The greatest increase was observed in Experimental group 2, while the smallest increase was observed in the control group (Figure 4).

3.3. Comparison of Levels of Planning Skills of Groups

Table 6.
Descriptive Results for Levels of Planning Skills of Groups

		Pretest		Posttest	
Groups	**N**	**Mean**	**Sd**	**Mean**	**Sd**
Experimental 1	20	17.5	4	19.9	3.3
Experimental 2	20	17.7	4.1	19.3	3.6
Control	20	16.8	3.1	17.8	2.9

All groups had higher TLT4 posttest than pretest scores. The greatest difference was in Experimental group 1, followed by Experimental 2 and control groups (Table 6). A split-plot ANOVA was used to determine whether the differences were statistically significant. Table 7 shows the results.

Table 7.
Split-Plot ANOVA Results for TLT4 Pretest-Posttest Scores

Source of Variance	**Sum of Squares**	**df**	**Mean Square**	**F**	**p**	**η^2_p**
Between groups	984.092	59				
Group (E1,E2,C)	43.517	2	21.758	1.319	0.276	0.044
Error	940.575	57	16.501			
Within Groups	620.5	60				
Measurement (Pretest-Posttest)	81.675	1	81.675	8.789	0.004	0.134
Group*Measurement	9.150	2	4.575	.492	0.614	0.017
Error	529.675	57	9.293			
Total	1604.592	119				

$^*p < 0.05$

The split-plot ANOVA results showed no significant group effect (F(2-57)= 1.319; p>.05), indicating that none of the groups had significantly different TLT4 scores, regardless of pretest and posttest measurements (Table 7).

The split-plot ANOVA results also showed that all groups had significantly higher TLT4 posttest than pretest scores (F(1-57)= 8.789; p<.05, η^2_p=.134), indicating that the FCM and IC-FCM accounted for 13% of the observed variance in TLT4 scores.

The split-plot ANOVA (Group*Measurement) analysis showed no statistically significant difference between TLT4 pretest and posttest scores across the three groups (F(2-57)=.492, p>.05, η^2_p=.017). This result suggested that none of the groups had significantly higher TLT4 posttest than pretest scores, rejecting the main hypothesis on planning skills. Figure 5 shows within-group variations in the TLT4 pretest and posttest scores.

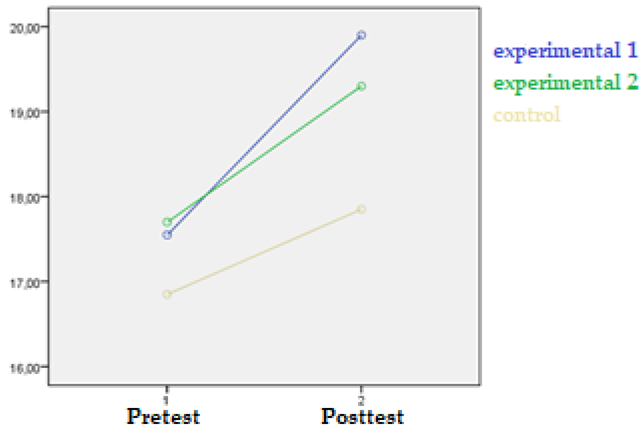

Figure 5. Within-group variations in TLT4 pretest and posttest scores

The FCM and IC-FCM improved students' planning skills, albeit insignificantly. The greatest improvement was observed in Experimental group 1, while the smallest improvement was observed in the control group (Figure 5).

Dependent groups t-test was used to determine the effectiveness of the FCM on students' academic achievement in science and social studies courses. To that end, SciLO and SocLO pretest and posttest scores were compared. There was a significant difference between SciLO pretest and posttest scores in Experimental group 1. The FCM explained 69% of the observed variance ($t_{(19)}$=-13.648, $p<.05$, η^2=.69) (Table 11). There was a significant difference between SocLO pretest and posttest scores in Experimental group 1. The FCM explained 89% of the observed variance ($t_{(19)}$=-25.97, $p<.05$, η^2=.89). The effect sizes showed that the FCM was more effective in social studies than in science.

Dependent groups t-test was used to determine the effectiveness of IC-FCM on students' academic achievement in science and social studies courses. To that end, SciLO and SocLO pretest and posttest scores were compared. There was a significant difference between SciLO pretest and posttest scores in Experimental group 2. The IC-FCM explained 80% of the observed variance ($t_{(19)}$=-18.300, $p<.05$, η^2=.80). There was a significant difference between SocLO pretest and posttest scores in Experimental group 2. The IC-FCM explained 76% of the observed variance ($t_{(19)}$=-16.242, $p<.05$, η^2=.76). The effect sizes showed that the IC-FCM was more effective in science than in social studies class.

3.4. Semi-structured Interview Results

Students' views were presented under two main categories: (1) students' views on the teaching process and (2) students' views on the improvement of the model. the first main category comprised of three subcategories: (1) students' experiences in the teaching process, (2) favorite part of the model, and (3) students' views on the animations and QR code activities. The second main category comprised two subcategories: (1) students' thoughts about watching materials at home or school and (2) students' thoughts about the effectiveness of the model on academic achievement in science and social studies courses.

3.4.1. Students' views on the teaching process

Students' experiences in the Teaching Process. Students' views on the teaching process were consolidated into ten codes and were grouped under two themes; "changes brought about by the model" and "feelings evoked by the model." Figure 6 shows the codes and themes regarding students' views on the teaching process.

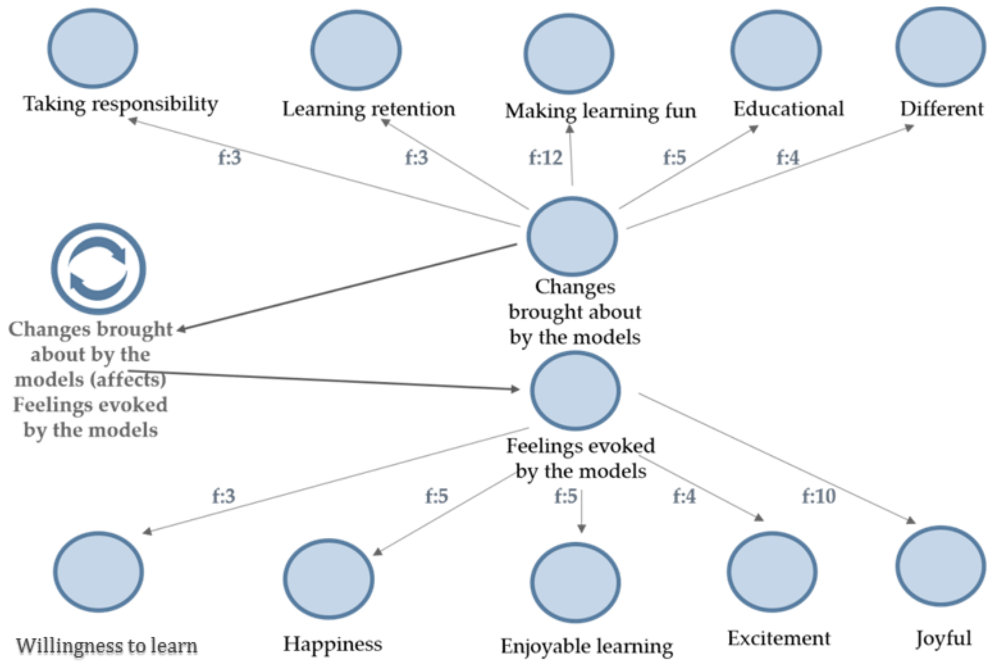

Figure 6. Codes and Themes regarding Students' Experiences in the Teaching Process

Students' views on the teaching process yielded the codes of "willingness to learn," "happiness," "enjoyable learning," "excitement," and "joyful." Participants stated that the models made them more willing to learn and happier and more excited and joyful about learning. They found the models different and fun and stated that they encouraged them to take more responsibility.

The theme "changes brought about by the models" consisted of the codes "taking responsibility," "learning retention," "making learning fun," "educational," and "different" (see Figure 6). Only three Experimental 1 participants associated the models with "taking responsibility." They stated that the different and fun activities of the models helped them take responsibility for their own learning and achieve learning retention.

Favourite Part of the Model. The subcategory "favorite part of the model" consisted of five codes; "QR code activities," "competitions," "puzzles," "animations," and "collaboration," which were grouped under the theme of "reaching information." Participants stated that the animations, QR code activities, competitions, and puzzles encouraged them to collaborate and made classes more fun.

Students' Views on Animations. Students' views on animations were grouped under the codes of "use of technology," "fun instruction," "multiple stimuli," and "appealing to children" under the theme of "conveying information enjoyably". Participants found the materials and activities with pictures and music enjoyable as they allowed them to use technology and teachers to use multiple stimuli when delivering classes. They also found the activities appealing because they included child characters voiced by children. They stated that the tips, images, and questions in the animations aroused their curiosity and encouraged them to learn.

Students' Views on QR Code Activities. Students' views on QR code activities were grouped under the codes of "technological skills," "reinforcing new knowledge," "fast learning," "teamwork and collaboration," "enjoying learning," and "containing information" under the theme of "reaching the information in an easy and fun way". The QR code activities were educational to participants because they helped them reach information, find clues, and acquire and reinforce new knowledge. Some of the participants regarded scanning the QR codes as a technological skill. They stated that they had no difficulty doing it because they were used to playing games on tablets. Some others stated that they had a little bit of hesitation at first but got used to it in a short time. The QR code activities promoted teamwork and collaboration.

3.4.2. Students' Views on the Improvement of the Models

Students' Thoughts about Watching Materials at Home or School. Students' thoughts about watching materials at home or school were coded as "technical issues," "teacher-guided learning," "inability to manage time at home," and "learning with classmates" under the theme of "collaborative learning at school." The theme of "learning at home" consisted of the codes of "distraction in the classroom," "taking responsibility," and "learning at your own pace." Figure 7 shows the themes and codes regarding students' thoughts about watching materials at home or school.

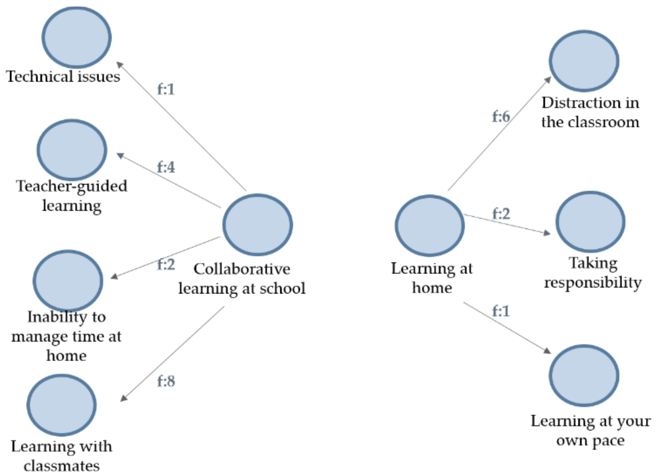

Figure 7. Themes and codes regarding students' thoughts about watching materials at home or school

Some participants stated that they preferred to watch the animations with their classmates because they thought they might encounter technical issues at home. An experimental 1 participant had had that problem before. Some participants stated that learning should occur at school under the teacher's guidance because they thought that only their teacher could help them with their problems. Some of them stated that they could not manage time effectively at home, while others found it more fun to watch the videos with their classmates. Experimental 2 participants watched the videos together at school. They were among those who preferred to watch the animations at school. Three Experimental 1 participants preferred to watch the animations at school, while the others preferred to watch them at home. An Experimental 1 participant stated that she preferred to watch the animations at school, if given the option, due to technical issues at home. Others stated that they did not like studying alone, or might forget to watch the animations, or found it more fun to watch them with their classmates.

Some participants preferred to watch the animations at home because they could watch them as many times as they wanted to and study more effectively without getting distracted as they would be in the classroom. Some participants thought that watching the animations at home meant taking responsibility for their own learning. All Experimental 1 participants preferred to watch the animations at school, while all but two Experimental 2 participants preferred to watch them at home.

Students' Thoughts about the Effectiveness of the Models on Academic Achievement in Science and Social Studies Courses. Most Experimental 1 participants found the FCM effective in their achievement in science and social studies courses, while most Experimental 2 participants found the IC-FCM effective in their achievement in science and social studies courses. Their views were grouped under the codes of "an easier class," "visuals in animations," and "loving the class". Some participants found the models more effective in social studies because they believed that the visuals in the animations made the class more manageable. They stated that the visuals of people from different countries and cultures promoted learning retention. One participant found social studies easier because he already knew about some of those countries. The theme for the science course had the code of "loving the class." One participant enjoyed the animations and QR code activities in science classes more and learned more quickly because she liked science better than social studies.

4. RESULTS, DISCUSSION and RECOMMENDATIONS

4.1. Results and Discussion

All groups had higher SciLO posttest than pretest scores. The differences between the SciLO posttest and pretest scores in the experimental groups were significantly higher than in the control group, suggesting that the FCM and IC-FCM were better at improving students' achievement in science classes than the SciCT. However, there was no significant difference in SciLO posttest scores between the experimental groups, indicating that the FCM and IC-FCM were not superior to each other in terms of students' achievement in science classes.

All groups had higher SocLO posttest than pretest scores. The differences between SocLO posttest and pretest scores in the experimental groups were significantly higher than in the control group, suggesting that the FCM and IC-FCM were better at improving students' achievement in social studies class than the ScoCT. However, there was no significant difference in SocLO posttest scores between the experimental groups, indicating that the FCM and IC-FCM were not superior to each other in terms of students' achievement in social studies classes.

The FCM and IC-FCM improved students' achievement in science and social studies classes more than did the SciCT and ScoCT. This result confirms the hypothesis of the study and agrees with the literature. Research shows that the FCM is better at improving students' achievement in science and social studies classes than traditional classroom models (Akgün & Atıcı, 2017; Bhagat et al., 2016; Chao et al., 2015; Çakır & Yaman, 2018; Elian & Hamaidi, 2018; Karaca & Ocak, 2017; Peterson, 2016). However, some studies reported no difference between the FCM and traditional classroom models because the FCM was new to students, and therefore, they could not get used to it and also because some students came to class without watching the assigned videos (Clark, 2015; Chen, 2016; Gregorius, 2017; Smith, 2015). Johnson and Renner (2012) also found no difference in academic achievement between students who received the FCM and a traditional classroom model because FCM in-class activities were implemented improperly and similar to traditional classroom activities.

The qualitative results also showed that the FCM was more effective than the SciCT and ScoCT. Participants stated that the FCM was full of fun activities they had never done before. They noted that the FCM ensured good learning retention and made them happy and enthusiastic about learning new things. Happiness and well-being increase academic achievement, and happy students are more successful (Quinn & Duckworth, 2007; Tabbodi, Rahgozar & Abadi, 2015). They enjoyed accessing digital content, doing activities that encouraged them to seek information, and collaborating to solve problems. Different learning and teamwork options motivate students (Torres, 2010). Ng and Chiu (2017) state that classrooms equipped with digital learning tools make students happy and joyful. Participants were happy doing the class with the FCM and IC-FCM. They stated that the models appealed to them because they included animations with children characters voiced by children and allowed them to use technology and the teachers to use multiple stimuli (images and music) and lecture in a fun way. Multimedia (sounds, graphics, and animations) educational materials with child characters appeal to young students and make them more attentive and motivated and better at learning and transferring knowledge (Lowe 2004; Nusir, Alsmadi, Al-Kabi & Sharadgah, 2012; Sinor, 2011). The qualitative results showed that participants bonded with the FCM and IC-FCM animation characters and talked to them or their classmates about them.

The result of FCM and IC-FCM were not superior to each other gives us some clues as to the effectiveness of the components of the FCM. The pre-class stage does not play a distinctive role in the effectiveness of the two models. In other words, watching videos at home or school does not make a difference in students' achievement. We can state that what matters is not whether students watch the course content at home or school but rather in what format the course content is presented and what activities it consists of. Research also shows that in-class activities play a critical role in the effectiveness of the FCM (Gojak, 2012; Hess, 2013; Overmyer, 2014). The time devoted to in-class activities plays a vital role in the effectiveness of the FCM (van Alten et al., 2019). According to Bergmann and Sams (2012), digital classes are only part of the FCM, and videos lay the groundwork for teacher-guided in-class active learning. Overmyer (2014) argues that the effectiveness of the FCM depends on the structure of the in-class stage. The qualitative results confirm that the in-class stage was effective enough to compensate for the differences in the pre-class stage between the FCM and IC-FCM.

The FCM and IC-FCM motivated participants to talk and ask questions about the lecture, get on with the activities, and participate in the in-class stage. The animations and QR code activities actively engaged them in their learning. The QR code activities encouraged them to follow instructions, plan, manage time, share tasks, and seek information. However, there was a difference in attitudes towards the videos between the experimental groups. Experimental group 2 wanted to watch the videos again, took notes while watching them, commented on the visuals, bonded with the characters, and talked to them or their classmates about them. Peer interaction is a manifestation of social constructivism in practice. Vygotsky (1978) argues that peer interaction helps students develop new skills and strategies. Agbatogun (2012) states that students who use technological tools during class interact more with their peers and teachers. Entezari and Javdan (2016) reached the result that in-class activities are instrumental in the FCM. It also supports our result that the FCM and IC-FCM were not superior to each other because they had the same in-class activities.

This study focused on effect sizes to determine the effect of the FCM and IC-FCM on students' achievement in science and social studies classes. The FCM explained 69% and 89% of students' achievement in science and social studies classes, respectively, indicating that the model was useful in both classes but more effective in social studies than in science. The IC-FCM explained 80% and 76% of students' achievement in science and social studies classes, respectively, indicating that the model was useful in both classes but slightly more effective in science than in social studies. Students may need more peers and teacher guidance in science class, so the in-class flipped classroom may have been more effective. Some participants stated that watching videos in school with peers helps to ask questions to each other and the teacher when needed. Besides, some experimental 2 group students stated that they liked science better than social studies, which may explain the result. Çetingöz and Özkal (2009) state that students' positive attitudes towards courses increase their performance. Research points out the positive correlation between attitudes towards science course and academic achievement (Çaycı & Kılıç, 2017; Hough & Piper, 2006). Our result is also supported by a meta-analysis concluding that the effectiveness of the FCM varies from discipline to discipline (Cheng, Ritzhaupt, & Antonenko 2019).

All groups had higher TLT4 post-test than pre-test scores, albeit insignificantly. This result shows that although all models helped participants develop planning skills, the FCM and IC-FCM were not more effective than SciCT and ScoCT. This study assumed that the FCM would be better at helping participants develop planning skills than the other models because it allowed them to watch the animations and take the tests at home before class (pre-class stage) and then perform the QR code activities to organize scattered information and use it correctly during class (in-class stage). The greatest improvement, though statistically insignificant, was observed in Experimental group 1, followed by experimental 2 and control groups. The qualitative results also showed that the QR code activities encouraged participants to follow instructions, manage time, collaborate, and plan. This result contradicts our assumption and the qualitative data, which may be because it takes longer than four weeks (duration of this study) to develop planning skills. Zheng et al. (2020) found that intervention durations has large impact on effectiveness of the flipped classroom.

There are limited published researches examining the effect of the FCM on planning or related executive function skills like self-regulation, time management, goal-setting, and control over learning (Bird, 2009; Vaughn, 2014; Sun, Wu & Lee, 2017). The reported results on the effect of the FCM on self-regulation, time management, self-management, and self-control support our result (Ahmed & Indurkhya; 2020; Sun et al., 2017; Talan & Gülseçen, 2018; Vaughn, 2014).

4.2. Limitations and Recommendations

Participants performed the FCM offline, that is, they could not use the online classroom management platforms because they had no Internet access at home. Future studies should recruit a sample with access to online classroom management platforms at home to examine the effect of FCM on academic achievement and planning skills.

There was no difference in academic achievement between FCM and IC-FCM participants. Both flipped classroom models are recommended for use in schools extensively; based on the research results, both models were effective on academic achievement. Future studies should address different in-class activities, course contents, materials, and formats to compare the two models. Teachers should consider students' responsibility levels and basic computer skills and expectations before deciding which model to use.

There was no significant effect of flipped classroom models on planning skills. In further studies, conducting longer intervention durations and considering students' studying habits recommended while examining flipped classrooms' effectiveness.

Research and Publication Ethics Statement

All participants gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ondokuz Mayıs University Social and Humanities Ethics Committee (approval no. 2016-97, date: 15.07.2016).

Contribution Rates of Authors to the Article

EGD implemented study activities in schools and carried out the data collection process. YÖ contributed to the determination of the research problem and the planning of the study. All authors read and approved the final manuscript.

Statement of Interest

The authors have no potential conflicts of interest to disclose.

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