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Flipped Classroom Experiences of Preservice Teachers: Implications from a Mathematics Course

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Abstract

The purpose of this research is to analyze the process of teaching mathematics through the flipped classroom model based on opinions of preservice teacher. The study group consisted of 16 preservice teachers, who were studying in the department of primary school teaching program at a state university in Turkey, and agreed to participate in the research voluntarily. The research was designed as a practical action research study. After the five-week implementation period, two separate focus group discussions occurred with the volunteer preservice teachers. Consequently, in addition to the positive contribution of the flipped classroom to learner responsibility, it was also observed that the in-class teamwork processes made a significant contribution about making the mathematics course entertaining. Moreover, peer learning was implemented, and the sense of belonging made a positive contribution to academic achievement in a teamwork process. In addition, preservice teachers started to see the academician as a role model at the end of the implementation process; this was a valuable result in terms of pedagogical contribution. Gamification or environments enriched with virtual reality applications can be suggested for further researches.

Öğretmen Adaylarının Ters-Yüz Edilmiş Sınıf Deneyimleri: Matematik Dersinden Çıkarımlar

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Öz

Bu araştırmanın amacı, dönüştürülmüş (tersyüz) sınıf modeli ile tasarlanan matematik öğretimi sürecini, öğretmen adaylarının görüşlerine dayalı olarak analiz etmektir. Çalışma grubu, Türkiye'de bir devlet üniversitesinde okuyan ve araştırmaya gönüllü olarak katılmayı kabul eden sınıf eğitimi programındaki 16 öğretmen adayından oluşmaktadır. Araştırma, uygulamalı eylem araştırması olarak tasarlanmıştır. Beş haftalık uygulama sürecinin ardından, gönüllü öğretmen adayları ile iki ayrı odak grup görüşmesi gerçekleştirilmiştir. Sonuç olarak, dönüştürülmüş sınıf modelinin, öğrenen sorumluluğuna olumlu katkı yapmasının yanı sıra sınıf içi grup çalışması ve matematik dersini eğlenceli hale getirmeye katkıda bulunduğu katılımcı görüşlerinden anlaşılmaktadır. Süreçte işbirlikli öğrenme etkinlikleri uygulanmıştır, grup çalışmaları sonucunda katılımcı görüşlerine yansıyan aidiyet duygusu ekip çalışması sürecinde akademik başarıya olumlu katkı sağlamıştır. Öğretmen adayları, uygulamanın sonunda dersin sorumlu öğretim üyesini rol model olarak görmeye başladıklarını ifade etmişlerdir. Bu, pedagojik açıdan değerli bir sonuç olarak değerlendirilmektedir. Yapılması planlanan araştırmalarda oyunlaştırma veya sanal gerçeklik uygulamaları ile zenginleştirilmiş ortamlar kullanılması önerilebilir.

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Introduction

The flipped classroom is defined as “performing the tasks that should be done in the classroom at home and performing the tasks that should be done as homework at home in the classroom” (Bergmann & Sams, 2012). This classroom also indicates that today's students are growing up with the opportunity to be web-enabled individuals. In addition, researchers have indicated that flipped classrooms align with the routine habits of today’s students. For instance, students can message each other on Facebook and listen to music while doing their mathematics homework. The difference of the flipped classrooms from the traditional classrooms was suggested by Bergmann and Sams (2012) as allocating five minutes for the warm-up activity, 10 minutes for the question-answer session regarding videos, and 75 minutes for the guided standalone or laboratory activities. This classroom format enables learners to access the course contents even when they are out of school, and do the assigned homework or activities in the classroom, instead of learning course contents only in the classroom environment and doing their homework at home. Thus, learners will have the opportunity to practice about twice as much as the traditional classroom environment through their activities under the guidance of teachers.

Active learning, cooperative learning and problem-solving, highlighted by Abeysekera and Dawson (2015) and Kim, Jung, Siqueira and Huber (2016), are expressed as the reason for the interest of the academic world in the flipped classroom model by Hao (2016). Sohrabi and Iraj (2016) examined this interest through the teachers' perspectives and have emphasized that the flipped classroom model provides the teachers an opportunity for creating more active and dynamic learning environments. When applying the model, unlike the traditional formulas for teaching and doing homework, the students learn the course content at their own learning speeds through online courses, researches and online discussions. In addition, the internalization of knowledge is carried out through cooperative studies (such as discussion, or retrospective evaluation) that are between peers and under the guidance of the teacher in the classroom to solve the targeted problems (Zhai, Gu, Liu, Liang & Tsai, 2017). Another important point defined by Kim, Jung Siqueira and Huber (2016), was that the guidance of teachers was identified as "coaching", "guiding" or "mentorship".

Chen and Chuang (2016) stated that, in traditional learning methods, teachers spend most of their preparation time on forming an interaction between the students and the material, and the interactions among the students are usually neglected. The researchers have regarded the flipped classrooms as in-class workshops in which students can query the knowledge, test their skills and form interactions through the activities. Similarly, according to Mohanty and Parida (2016), flipped learning changes the teachers' distribution of teacher time. Instead of taking care of only those students who ask questions during the course, flipped learning also enables the teachers to help students who remain quiet.

Although it has been stated that flipped learning causes changes in the distribution of teacher time, according to Arnold-Garza (2014), online resources such as Khan Academy, Coursera and TED Talks, which have been associated with the flipped classroom, and finding and preparing appropriate videos on YouTube require a significant time expenditure. In addition, according to Unruh, Peters and Willis (2016), in the flipped learning model, technology integration plays a fundamental role in the course design process. In this regard, technological competence of the teachers needs to be considered. To succeed in the flipped classroom model, Mok (2014) noted 2 prerequisites. These prerequisites are that students should attend a course to engage in active learning activities and they should attend the course after watching the video lessons prepared for each session.

When the research conducted using the flipped classroom model are analyzed, the findings showing that this model increases success can be found in the researches by Little (2015), Flores, Del-Arco and Silva (2016), Turan and Goktas (2016) and Şengel (2016), Kurt (2017). On the other hand, He, Holton, Farkas and Warschauer (2016) have indicated that the model leads to a slight but statistically significant increase in final exams. In addition to these positive findings, according to Adnan (2017), there is no significant difference between the experimental and control groups in terms of mid-term exams and e-portfolio scores. Fraga and Harmon (2014) also indicated that there is no significant difference between the experimental group and the control group in terms of academic achievement.

Although various results were revealed suggesting that the flipped classroom model makes a significant difference in increasing academic achievement (Sahin, Cavlazoglu & Zetuncu, 2015), its positive effect on other

factors which are apart from academic success and also directly affect the learning process is remarkable. The examples of these positive results observed in certain researchers can be seen below:

Higher perception of self-efficacy in the experimental group (Kurt, 2017);

Positive effect on shy and quiet students (Zainuddin & Attaran, 2016);

Possible to watch the videos repeatedly (Mok, 2014);

Satisfactory learning experience (Adnan, 2017);

Positive effect on learner participation (Little, 2015);

Learning at their own speeds, flexible time and location, and 'practicing before the lecture is given in class' has a positive effect on the 'in-class activities' (Choi & Lee, 2015; Johnston, 2017);

Positive effect on the students' beliefs about their internal motivations and self-efficacies (Thai, Weber & Valcke, 2017);

Support more active courses inside or outside of class (Lesseig & Krouss, 2017);

Improvement of student learning performance (Akçayır & Akçayır, 2018); and

He, Holton, Farkas and Warschauer (2016) noted the benefits of the flipped classroom model as the following: learning at one's own speed, better preparation for class, more problem-solving and greater teacher-student interaction. However, the researchers have also criticized the model because of the fact that this model do not provide an increase in the total study time of students, but they only increase their work loads. Furthermore, the researchers have stated that all the student opinions were positive, and they emphasized the importance of the initial motivation and readiness. Similarly, O'Flaherty and Phillips (2015) indicated that there are many findings in the literature showing that the flipped classroom model increases academic performance and student and instructor satisfaction indirectly. However, the researchers also stated that there are insufficient findings related to any contribution of the model to lifelong learning and the enhancement of 21st century skills at the bachelor's and postgraduate levels.

In research based on teachers' opinions, Wang (2017) stated that there are first-level barriers, such as the access of middle-school teachers' and students' to tech-supported courses, teachers' preparation time of teachers, and technical support, and second-level barriers, such as technological and pedagogical beliefs of teachers and the teacher's self-confidence, attitude and resistance to change. Jungic, Kaur, Mulholland and Xin (2015) suggested that these elements really can teach make a difference. Moreover, Al-Zahrani (2015) stated that flipped classroom model may facilitate the creativity of students. Araujo, Otten and Birisci (2017) identified cooperation, student participation and the increased time spent in class as the main advantages and pre-course preparation time and ensuring the students watch the videos as the main difficulties. When these advantages are analyzed, the emphasis on increasing cooperation among the students can be observed. As a result of this cooperation, the students no longer wait for their teachers' help. The students who became more active due to the increase in learner participation take more responsibility regarding their learning. In addition, watching the videos in advance is another factor that positively affects student participation. The increased time spent in class led the teachers to assist the students more and to provide help to students when they attempt to overcome a difficulty. The difficulty in the process of utilizing the flipped classroom model for the first time was about the time teacher spent in preparing the materials (especially videos) and the course plan.

Researches reveal that flipped classrooms enable on active learning activities, and have positive effects upon learning performance and motivation. These advantages of flipped classroom model are considered as an opportunity to use active learning activities in the Basic Mathematics course, which has an intensive content and has two hours weekly. Whether this is regarded in the same way from the point of view of the students and determining the views of the students in order to improve the implementation process is one of the important issues to be considered. Therefore, in this research the purpose of the research was to investigate the preservice primary teachers' opinions regarding the flipped classroom model. In accordance with this primary purpose, we searched for answers to the main research question as "*What are the participants' opinions on the flipped classroom model?*" and sub-questions provided below:

SRQ1: What are the participants' opinions regarding the videos they watched?

SRQ2: How did the real-life problems affect the instructional design?

SRQ3: How did the instructional design affect participants' professional development?

SRQ4: What are the participants' suggestions for improving the instructional design?

Method

Research Design

Because the allocated time to improve problem-solving performances of preservice teachers' was insufficient, the research was designed as a practical action research study; one of the qualitative research methods, based on testing and evaluating implementation

The starting point of this research was the fact that the allocated time for the course is not sufficient when the mathematics courses are taught with the objective of increasing the preservice teachers' problem-solving performances. This fact created the need to conduct a practice-based instructional design trial with a theoretical teaching method that is supported by pre-course preparations. From this point forward, the purpose of the research was to determine the preservice primary teachers' opinions regarding the flipped classroom model.

Study Group

In the determination of the participants, approximately 110 undergraduate students studying in the primary school program teaching were interviewed and informed about the research process and about what preservice teachers are expected to do during this process. The research study group consisted of 16 preservice teachers (11 women and 5 men) from a primary school teaching program who agreed to participate voluntarily. The implementation process involved freshmen who had taken the undergraduate mathematics course. The participants of the study were composed of participants who completed their high school education in different cities, from different socioeconomic backgrounds, ages ranging from 18 to 22, and who were studying in the department of primary school teaching at the state university. Participants were asked to work in groups of three-four they chose.

Implementation

Due to the nature of the flipped classroom model, the implementation process was planned separately by the researchers as in-class and out-of-class activities. In the process of planning out-of-class activities, firstly, the researchers searched for online materials to provide the topics covered in the research. In accordance with the research purpose, Massive Open Online Courses (MOOCs) that are to be used in non-class course preparations for ordered pair and Cartesian products, relations and functions, function graphs, linear equations and graphs were reviewed. Before the lesson, the videos obtained from these resources were evaluated with respect to the suitability to the requirements, the adequacy of mathematical language usage, the technological characteristics and the mathematical content in accordance with the opinions of 1 mathematics field expert, 2 mathematics education experts and 1 technology expert; and they were also made ready for technical sharing. During the 5-week implementation period, 35 videos, total 158 minutes, were shared with the preservice teachers. The average number of videos shared per week was 7, and their mean time was 31.6 minutes. The prepared videos were delivered to the participants through WhatsApp.

In-class activities carried out during the implementation process, daily life problems and modelling activities were utilized. The activities, which were presented to the students as contextual problems, were developed by the researchers. In the structure of the activities, it was aimed to develop the competence and mathematical language use of the students in the field, and to enable them to establish the relationship between mathematics and daily life. During the in-class activities, all the problems and scenarios were solved by the preservice teachers working in groups of 4. The detailed information related to the activities implemented is provided in Table 1.

Table 1. Detailed Information Regarding Activities

Week	Name of the Activity	Course Content	Context
1	*Cabin Crew*	ordered pair and Cartesian product	Making matches of appropriate seats and meals that passengers can eat according to special dining categories,
2	*Flight Checklist & Valentine's Day*	Cartesian product, the relation and its properties (reflection)	Finding how many matches can be made independent of the tail numbers and the runway numbers of the planes. Giving presents to couples in a Valentine's Day organization,
3	*Blood Exchange*	the properties of the relation and the concept of function	Creating a model for blood exchange using the information on blood groups and the Rh antigen,
4	*Yoga Course*	the concepts of function and linear relationship	Identifying the most appropriate subscription alternative based on a fee,
5	*Call Center*	function types, inverse function, function graphs and linear relationship	Identifying the relationship between the sequence number of any customer and his/her estimated waiting time.

Data Collection

So as to collect data, two separate focus group discussions were conducted with the freshmen. Seven preservice teachers participated in each focus group discussion. There were seven female students in the 1st focus group discussion, and there were four male students and three female students in the 2nd focus group discussion. The "semi-structured interview forms" developed by the researchers were used to collect the research data. When organizing the interview forms, the research on the subject was reviewed, and the interview questions were designed. The interview form consists of 12 questions related to the collaboration, motivation, pre-class and in-class processes of the flipped classroom implementation.

Data Analysis

Approximately one-hour long interviews were recorded with a camera with the permission of the participants. The electronic data were converted into Word documents, and nicknames such as S1 and S2 were used for the participants, and R for the researcher. The raw data obtained were coded using the Content Analysis Technique (Yıldırım & Şimşek, 2008), and the themes were determined.

To determine the internal validity of the research, the findings were supported by the previous research. To determine the external validity, we attempted to delineate the research method, and essential explanations were provided to enable the findings to be tested in other research studies. To ensure external reliability, the research findings were supported by providing exact citations from the interviews; the research process was explicitly delineated. Different opinions and alternative explanations were included in the findings, and the raw data of the research was preserved so that other researchers can use them. To ensure internal reliability, the research questions were explicitly delineated, and attempts were made to collect the specific data using suitable research questions (Miles & Huberman, 1994). In addition, to increase internal reliability, a randomly designated interview form was coded separately by the researcher and by an academician who has qualitative research experience, and the inter rater reliability was examined. Using the "[Agreement / (Agreement + Disagreement)] x 100" formula, the coefficient of agreement between the two coders was found to be .89.

Findings

The analysis results of the 14 participants' answers to the open-ended focus group discussion questions are provided in this section. The content analysis results obtained from the participants' opinions were organized and collected under five main themes: *preliminary preparation, activity, professional development, flipped classroom model, and suggestions*. The code, sub-theme and themes reached within the context of the participants' opinions are presented in Table 2. Findings on the themes are presented separately and during themes below.

Table 2. Detailed Information Regarding Activities

Themes	Sub-themes	Codes and (frequencies)
Preliminary Preparation	Course videos	The problems solved (1); Content (3); Duration (2); Contribution to science (3)
	Studying	Lecture notes (4); Studying hours (5); Learner responsibility (2)
	Preferences	Needs (3); Frequent usage (6)
Activity	Group	Entertainment (4); Discussion (3); Peer learning (3); Cooperation (3); Equality of opportunity (2); The sense of belongings (2)
	Real life problems	Distinctness (1); Entertainment (3); Expectation (1); Concretization (1); Conceptual learning (5); Effective (4); Viewpoints (2); Pleasure of achievement (2)
	Active learning	Recalling knowledge (1)
Professional Development	Field instruction	Mathematical literacy (5); Guidance (2); Special field knowledge (3)
	Skill	Problem-solving (2); Critical thinking (3); Patience (1)
	Professional teaching knowledge	Concrete operations (2); Storifying (1); Role model (5); Personal development (2)
Flipped Classroom Model	Learning	Learning through experience and practicing (3); Entertaining course (3)
	Communication	Instructor (5); Educational environment (6); Peer-to-peer communication (3); Intra-group communication (2)
	Motivation	Expectation of qualification (1); Hesitation (1); Classroom size (14)
Suggestions	Course content	Central System Common Exams (1); Instructor videos (1)
	Incentive reward	Chocolate (1); Score (1); Candy (1)
	Competition	Duration (1); Participation (1)
	Concrete materials	Model (1)

The Preliminary Preparation Process

The theme, sub-theme and code list of the preliminary preparation theme and sample opinions of participants are presented in Table 3.

Table 3. Sub-theme and code list of the preliminary preparation theme

Preliminary Preparation		
Sub-Themes	**Codes and (frequencies)**	**Sample opinion**
Course videos	The problems solved (1); Content (3); Duration (2); Contribution to science (3)	S10. *I think their short durations are fine but I didn't like it as they were not taken too short. Interrupting the subject in every 2 minutes, 3 minutes distracts. I think interrupting the subject was not good; duration of 6-7 minutes was better*. Concluding a subject rapidly was better. S12. *The content of the videos was sufficient. We didn't need to do any work on it.* S7. *I think there could be more clear examples. For example, I could not understand some examples.*
Studying	Lecture notes (4); Studying hours (5); Learner responsibility (2)	S5: My brother just started high school. When he was at secondary school he used study watching videos, but studying like this was difficult for me cause *I feel the need of seeing the questions written on a paper, taking notes from the course books and making researches*. If I can't understand through the books, then I may search in the internet. S9. *And also as we have watched the videos in advance, I realized that in fact I am a student. I comprehended this responsibility*.
Preference	Needs (3); Frequent usage (6)	S1. *WhatsApp is the commonly used application.* S4. *We were able to open and watch them on our smartphones while walking or when we took a bus, or while doing a teamwork assignment where we were hanging out with my frequent or normal group of friends*.

The participant opinions regarding the course videos, which provided the foundation for the flipped classroom, can be dealt with the problem solved, content, duration and contribution to science topics. Three participants evaluated the content of the videos sent before the course as "sufficient"; however, S7 indicated that the problems solved in videos should be more explicit. As it can be seen from the participants' statements (S10 and S14), the ideal duration of the course videos is approximately seven minutes. Furthermore, the results show that the subject was lectured as a whole and did not cause a loss of motivation as it was not excessively long. Participant opinions regarding video durations are provided as: "*S14. I was watching them completely anyway, but I think to watch in parts is the best method for not only one student, but everyone. I think 7-8 minute-videos were the most appropriate ones. It was possible to watch a video and conclude a subject in one sitting. Because this way you were able to know where to keep going".*

The lecture notes, studying hours, the effects of learner responsibility upon the course preparation were also noted. The participants who preferred the lecture notes provided notes as a summary to the videos. That these participants did not seek lecture notes from another resource is noted in their opinions. In this regard, from the statements of S14, it is understood that the study durations were "as much as the durations of the videos". The most remarkable point was set forth by the learner responsibility. Opinions regarding this topic are provided below:

S9. And also as we have watched the videos in advance, I realized that in fact I am a student. I comprehended this responsibility.

S11. We were trying to deduce from those videos in our own rights, but everyone assigned a different meaning to the videos you have sent in the last week. For example, some students stated that they used to draw the disequilibrium in that system in a different way. Everybody may consider from their own viewpoints. This is because the subjects are not lectured to the whole class.

S9's statement "I realized that in fact I am a student", and S11's statement, "Everyone interprets in a different way" both provide important insights regarding the usage of flipped classroom.

There are "entertaining, needs and frequent usage" topics in the concept of "preference in preliminary preparations" headings. About the "entertaining" code, it was observed that the videos were deemed as more entertaining than the lecture notes, and with the "needs" code, that the participants prepared lecture notes using the course videos with the objective of ensuring permanent learning. Also, for the "frequent usage", the participants explained why they preferred WhatsApp to access the course videos: "*S1. WhatsApp is the commonly used application. For example, some of our friends do not have a Facebook account, and some of them do not use Instagram".*

As it can be understood from the participant opinions, WhatsApp is used more commonly than the other social media applications. Another finding is that this application can be used as an effective and favourite communication channel to send the participants approximately seven-minute course videos; this was also proffered by the participants. The reasons for the WhatsApp preference can be observed more explicitly through the "repeating and location" codes.

S5. After downloading a video in WhatsApp, there will be no problem if you watch it even 50 times. But downloading and waiting for it may be a problem on social media.

S4. We were able to open and watch them on our smartphones while walking or when we took a bus, or while doing a teamwork assignment where we were hanging out with my frequent or normal group of friends.

The participants evaluated being able to watch the course videos repeatedly as a significant convenience while getting around or during the teamwork assignment without an internet connection after they downloaded these to their smart phones via the WhatsApp application. In addition, the feedback regarding the duration of these videos are considered important. The comments on mobile learning advantage showed that the fact that WhatsApp is proffered as a tool that can be used for the flipped classroom model is an important finding.

The Activities

The theme, sub-theme and code list of the activity theme and sample opinions of participants are presented in Table 4.

Table 4. Sub-theme and code list of the activity theme

Activity		
Sub-Themes	**Codes and (frequencies)**	**Sample opinion**
Group	Entertainment (4); Discussion (3); Peer learning (3); Cooperation (3); Equality of opportunity (2); The sense of belongings (2)	S11. *We really enjoyed this.* S5: *It was a discussion environment in which we discussed through intellectualizing and asking if it would be better if it was done another way.* S12. *All of us were participating in a different way and we were completing each other.* S5. *Sometimes we can't understand when our teacher lectures, but we think that we understood it when one of our friends explains it.* S13. *When the classroom size was 50, each of us didn't have a chance to speak, but being in groups had the advantage of having the right to speak.* S9. *I reviewed my previous year's notes after watching the videos only in the first week, just to understand the subject better and not to be embarrassed toward my friends.*
Real life problems	Distinctness (1); Entertainment (3); Expectation (1); Concretization (1); Conceptual learning (5); Effective (4); Viewpoints (2); Pleasure of achievement (2)	S5. *… it was better that way. For example, we were framing it; when a question was asked about the planes, we were visualizing a plane and asking ourselves how they used to do…* S7. *We used to study considering the input-output. Instead of reasoning, we used to proceed only using the formulas directly. We were not engaging in any discussions. But when we started to reason and to interpret a little bit, we opened a new window; I mean our perspectives were broadened.* S11. *It is possible to achieve permanent learning only when you put your existing knowledge into practice.* S2. *"It was difficult, but I solved it". Feeling this pleasure is also very important.*
Active Learning	Recalling knowledge (1)	S5. Our teacher was solving it in the classroom, or asking one of us to solve it at most. But in here, our teacher gave us the sheet and we got used to solving problems. *We were trying to recall our previous knowledge*; therefore it was more effective for us.

The participants' thoughts regarding the activities they engaged in during the course hours were compiled under the "group, active learning and real-life problems" headings. The "group" sub-theme provides important insights about the contribution of the group activities to the academic achievement or about their social contributions. Especially the "entertainment" code they strongly expressed in the interview shows that the problem-solving process became more entertaining. S11's opinions regarding entertainment are "*S11. I am sure you have observed in the voice records or videos how our group studied and laughed raucously. We really enjoyed this".*

In addition to identifying the learning-teaching process as an entertaining process, S5 explains the contribution of the discussion environment within the group, which was enriched by the academician's facilitation: "*S5: It was a discussion environment in which we discussed through intellectualizing and asking if it would be better if it was done another way".*

Creating an entertaining discussion environment to which participants contribute with their own ideas is deemed very significant. After creating such a discussion environment, the "cooperation and peer learning" codes produced results that corroborate the current learning-teaching approaches. The statements of S12 explicitly show the positive results of the cooperation and peer learning (S5's opinion) actualized through the teamwork.

S12. I really liked being altogether during the teamwork process. For instance, S8 was very good at equating, and S9 was suggesting realistic ideas. S13 was watching silently and then suggesting something else and was suddenly solving the problem. All of us were participating in a different way and we were completing each other.

S5. I saw how my friend was doing it; how he was using that formula. Sometimes we can't understand when our teacher lectures, but we think that we understood it when one of our friends explains it. Now it just happened the same.

The "equality of opportunity" and "sense of belonging" codes, which can be viewed as prerequisites to generating the important points noted above, reveal other important issues that reflect the participant opinions. S13 who emphasized the equality of opportunity theme through referring to the classroom size summarized the contribution of teamwork process as "*S13. When the classroom size was 50, each of us didn't have a chance to speak, but being in groups had the advantage of having the right to speak. But as we were only 4 students in the group, a part of that 25% was individualized".*

Besides 'the equality of opportunity' code, S5 and S9 stated that the emotion which is the basis for the success of any activities with the belonging code, by emphasizing the responsibility of collaboration.

S5. And another important thing is that we are a group, so how can I let down my friend?

S9. I reviewed my previous year's notes after watching the videos only in the first week, just to understand the subject better and not to be embarrassed toward my friends.

In the interview, through the questions about real-life problems, the participants' thoughts regarding the in-class activities were examined. These questions set forward the most extensive topics: "distinctness, entertainment, expectation, concretization, conceptual learning, effective, viewpoints, memorability, pleasure of achievement, researching and acquaintance". The participants' opinions that summarize the expectations at the beginning of the course are provided as "*S5. … it was better that way. For example, we were framing it; when a question was asked about the planes, we were visualizing a plane and asking ourselves how they used to do…".*

Since the activities are expected to consist of classic-type questions including daily life or modelling problems, the difficulties encountered during the acquaintance stage were resolved within a short time, and the distinctness evolved into an entertaining process through various viewpoints. S7 defined this situation below by comparing it to the previous learning processes: "*S7. We used to study considering the input-output. Instead of reasoning, we used to proceed only using the formulas directly. We were not engaging in any discussions. But when we started to reason and to interpret a little bit, we opened a new window; I mean our perspectives were broadened".*

After different viewpoints were offered to solve the problems encountered, positive feedback on permanent learning was obtained as a result of actualizing the conceptual learning. This situation was summarized by S11 as "*S11. It is possible to achieve permanent learning only when you put your existing knowledge into practice. It doesn't matter if you read too much or if you have knowledge about many things. As long as you don't put them into practice and apply them in your daily life, you will be putting aside and will forget them sometime later, because they will not be serving a useful purpose. But we are always repeating. As soon as we receive the videos, we are repeating at home, and also the more we watch, the more we repeat. Besides, when we come here, we put them into practice, and this way they become permanent".*

Another important point to note is the "pleasure of achievement", which was identified as a case experienced after solving modelling or real-life problems. The pleasure created by the different perspectives' reaching a conclusion in cooperation can be understood from the opinions of the S2 as an important motivation source: "*S2. It was difficult, but I solved it. Feeling this pleasure is also very important".*

As a consequence of solving real life problems through group activities, how it was concluded as "active learning" was summarized by S5 as fallows: "*S5. Our teacher was solving it in the classroom or asking one of us to solve it at most. But in here, our teacher gave us the sheet and we got used to solving problems. We were trying to recall our previous knowledge; therefore, it was more effective for us".*

Implementing peer learning effectively in an entertaining discussion environment through teamwork processes and concretizing the real-life usage of mathematics through activities are deemed important

achievements. In addition, the reinforcement of the sense of belonging and the pleasure of achievement must also be emphasized.

Contribution of the Professional Development

The theme, sub-theme and code list of the professional development theme and sample opinions of participants are presented in Table 5.

Table 5. Sub-theme and code list of the professional development theme

Professional Development		
Sub-Themes	**Codes and (frequencies)**	**Sample opinion**
Field instruction	Mathematical literacy (5); Guidance (2); Special field knowledge (3)	S10. *But I have difficulties in using mathematical literacy.* S14. *I learned how to form an equation now. I will never forget it because it is engraved on my mind. I learned what the injective function is, what the surjective function is.*
Skill	Problem-solving (2); Critical thinking (3); Patience (1)	S7. *I think we should not see it only as mathematics; it will be useful also when we encounter with a different problem*. S9. *I think this project also enriched me. It makes me a critical thinker*. S2. *I think our patience thresholds improved*.
Professional teaching knowledge	Concrete operations (2); Storifying (1); Role model (5); Personal development (2)	S7. *As a matter of fact, they don't have high levels of intelligence required to understand it abstractly. So I have to explain by giving examples to ensure permanent learning*. S5. *Sir, at the end of the day, we are going to be primary teachers. We need to be able to teach mathematics to the children in a way that is related to real life.* S4. *For example, we may storify*. S1. *I am going to be a teacher. The way I will instruct the children will be like this*.

The professional development theme that conveys the remarkable results of this research consists of 3 sub-themes, which are "the field instruction, skills and professional teaching knowledge". In the "field instruction", the situation that was primarily emphasized and considered a "difficulty" was reflected through "mathematical literacy" as "*S10. As a matter of fact, I am normally good at mathematics. I don't have too many difficulties in solving the problems. But I have difficulties in using mathematical literacy. I have great difficulty in expressing. However, I think I made a progress in this. Now I can write to some degree"*.

The steps of the process are considered a possible reason for the difficulty encountered in the mathematical literacy used during the problem-solving process. To lessen the effect, the academician's guidance was restated by a preservice teacher through the "guidance" code. Despite opposing thoughts, S14 summarized the participants' positive thoughts regarding the mathematics instruction through the "content knowledge" code as follows: "*S14. I learned how to form an equation now. I will never forget it because it is engraved on my mind. I learned what the injective function is, what the surjective function is. In fact they are very easy, but I used to be unsuccessful. Well, they are very easy, our teacher was explaining, I was studying for the exams but later I was forgetting what I have learned. Although they are easy, I was unable to recall"*.

In accordance with the participants' opinions, "the problem-solving, critical thinking and patience" topics were found under the "skills" sub-theme. Whereas the problem-solving is assessed as an expected situation, the critical thinking and patience can be defined as the skills that play an important role in the learning-teaching process. The participants' opinions are provided below:

S9. I think this project also enriched me. It makes me a critical thinker.

S2 I think our patience thresholds improved. We thought of quitting a few times, but we stayed because we knew that we should solve the problem.

Another important sub-theme under the "professional development" theme is "professional knowledge for teaching". In addition to the learning and teaching dimensions of the flipped classroom model, this model also sets forth pedagogical contribution to preservice teachers. The "concrete operations, storifying, role model and personal development" codes, which were emphasized by the participants, constitute the pedagogical effect. Besides, the contribution of the activities conducted through the 'personal development' code to mathematical knowledge for teaching, an opinion that summarizes that these activities have contributions to different areas is as follows: "*S7. I think we should not see it only as mathematics; it will be useful also when we encounter a different problem".*

The "concrete operations and storifying" codes draw attention pedagogically. In both codes, the opinions addressing the ages the elementary school students and how important it is to relate with real life are provided below:

S7. We will take care of the underage children. It is required to give examples of real-life situations. The children ask me to give illustrations. As a matter of fact, they don't have high levels of intelligence required to understand it abstractly. So I have to explain by giving examples to ensure permanent learning.

S5. Sir, at the end of the day, we are going to be primary teachers. We need to be able to teach mathematics to the children in a way that is related to real life.

S4. For example, we may storify.

The "role model", which was reflected on participants' comments, lead to the belief that the mathematics course activity incorporated functions of the Teaching Methods course. The opinions supporting these findings are provided below:

S1. I am going to be a teacher. The way I will instruct the children will be like this.

S4. For example, in our courses, we may think about performing flipped classroom together with practical examples for the kids.

S11. Through being students in here, we observed how our students may act when conducting an activity at school. ... We have quit implementing teamwork processes and conducting activities... But while studying at the university and being so close to our professional life; you gave us a chance to observe those studies again.

When the professional development is regarded in general terms, it enables the research to be evaluated as productive in terms of both the mathematics instruction and the pedagogical principles. The belief that this theme may also contribute to the problem-solving processes beyond mathematics is considered an important acquirement.

The Flipped Classroom Model

The theme, sub-theme and code list of the flipped classroom theme and sample opinions of participants are presented in Table 6.

Table 6. Sub-theme and code list of the flipped classroom theme

Flipped Classroom Model		
Sub-Themes	**Codes and (frequencies)**	**Sample opinion**
Learning	Learning through experience and practicing (3); Entertaining course (3)	S10. *Since primary school, I have never had this much fun in a mathematics course*. S8. *Within this process, I learned what mathematics knowledge is supposed to do in our daily lives*.
Communication	Instructor (5); Educational environment (6); Peer-to-peer communication (3); Intra-group communication (2)	S5. *We communicated with our instructor* so easily. S13. *Furthermore, our friendships became stronger*. S2. … *In such an environment we could express our thoughts so easily because the atmosphere became warmer*. *When appropriate, we had discussions with our peers.*
Motivation	Expectation of qualification (1); Hesitation (1); Classroom size (14)	S4. *In a usual system of education there is a teacher lecturing in the mathematics course. Let's see if it will be more beneficial, or not? What kind of experience will it be for us? Just to have something different.* S7. *I preferred it mainly because the other classroom is too crowded. It is more difficult to understand the course in a crowded classroom*.

The participants' opinions on the learning-teaching process is combined under the "motivation, learning, and communication" sub-themes. As for "motivation", according to S4's opinion, one of the important issue on the learning-teaching process is that participants had some question marks before the implementation: "*In general, the teacher lectures in the mathematics course. Let's see if it will be more beneficial, or not. What kind of experience will it be for us?*" S4's opinions are remarkable since these opinions explained an expectation qualitatively, and the participants defined the traditional methods' ordinariness. Another reason why the participants agreed to participate was set forth through the classroom size. When the participants compared themselves to the other group, all consider themselves advantageous. The "entertaining course flipped classroom and learning through experience and practicing" codes arise as the reasons why the participants considered themselves advantageous. S10's comments that the course was entertaining are summarized below: "*It was highly enjoyable. Since primary school, I have never had this much fun in a mathematics course. I did not see it as an activity.*"

The fact that a course was identified as "entertaining" by the participants can be interpreted as the first step towards success. In addition to entertainment, the fact that mathematics ceased to be an abstract course in which the participants attempted to find solutions using real-life problems was an important point according to S8. Also, another advantage of having the in-class activities that consist of real-life problems was defined by S10.

S8. Within this process, I learned what mathematics knowledge is supposed to do in our daily lives. You did not ask us what two times two is, but how two times two is four.

S10. … When I first watched it in here, I did not understand so much. It was effective for me after I attended the course, started to solve problems by associating them. I was trying to solve by linking them with that week's video. This way of learning was more permanent.

It is understood from S10's comments that a course becomes more effective through the combination of conducting in-class activities and watching the videos before the course. The communication (instructor, peer-to-peer communication) should be considered in explaining the in-class activities' effect within the flipped classroom model. Some opinions showing that there was effective and warm communication in the educational environment are provided below:

S5. We communicated with our instructor so easily.

S13. Furthermore, our friendships became stronger. As a matter of fact it was our 3rd week, I guess S2 made a cake for us and brought it to the classroom.

S2. … In such an environment we could express our thoughts so easily because the atmosphere became warmer. When appropriate, we had discussions with our peers. We expressed ourselves in a better way.

When the process is evaluated as a whole, it is possible that the flipped classroom, which begins with the questions of "Can we do it?", "Can we understand it?", and "How productive can it be?" was perceived as a productive and entertaining course through activities including real-life problems. It was observed that the activities conducted with four-student groups and in an educational environment suitable for the teamwork process provides positive results academically and in terms of communication.

Suggestions for the Instructional Design

The theme, sub-theme and code list of the suggestions theme and sample opinions of participants are presented in Table 7.

Table 7. Sub-theme and code list of the suggestions theme

Suggestions		
Sub-Themes	**Codes and (frequencies)**	**Sample opinion**
Course content	Central System Common Exams (1); Instructor videos (1)	S14. *I am not sure whether I can answer the questions correctly using the knowledge you instructed if I take again the Transition to Higher Education Examination (YGS)*. By increasing the number of the questions we may vary them. Learning is the most logical thing but in the end we have to accept that the system is doesn't let. We have nothing to do. We have to study according to the system. S12. *We find it more sympathetic to hear a tone of voice we are familiar to*.
Incentive reward	Chocolate (1); Score (1); Candy (1)	S14. *At the end, only a 25 cents candy*. S12. *We will be very happy if you put in an incentive reward. For example, chocolates will be appreciated… Sir, as an incentive reward, maybe you could give each of us 10 points as we studied hard.*
Competition	Duration (1); Participation (1)	S5. *For example, after proceeding a while we could utilize a duration button to see how each group proceeds in the process in how many minutes*. S3. *… Conducting some activities during the course such as simple competitions may be useful for enabling all group members to participate. They may have a tendency to finish the activity quickly and to get the incentive reward*. S12. *We were always the last ones leaving the class*. I was always competing for leaving earlier. At least we may leave as the second last ones; I mean not being the last group.
Concrete materials	Model (1)	S5. *If there was something concrete such as a garden or a house question, we could review its shape and make inferences directly*.

The participants' suggestions for making the implementation more effective can be summarized as “course content, incentive reward, competition and concrete materials” sub-themes. As for the “instructor videos” code, certain comments showed that the videos made by the instructor can be more motivating and more sympathetic. In addition, the “model usage” shows that participants believed that concrete models of the real-life problems that they attempted to solve during the course can be used as “*S5. There might have been systems in which we could solve the problems using a more concrete material… It could be customized for us [grade level]… If there was something concrete such as a garden or a house question, we could review its shape and make inferences directly”.*

The “competition and incentive reward” sub-themes that are considered interrelated refer to using small incentive but non irritating rewards that will corroborate the sense of competition and that can be used among the

groups in the flipped classroom model. The chocolate, score and candy examples of participants are reflective belief that incentives should be provided after the abovementioned entertaining competition.

S12. We will be very happy if you put in an incentive reward. For example, chocolates will be appreciated… Sir, as an incentive reward, maybe you could give each of us 10 points as we studied hard.

In reference to "competition", S5's comments show that participants prefer the problem-solving process should be focus on sequencing instead of time limitations. Additionally, S3's opinions reflect providing motivation within the group as well as the intergroup competition.

S5. For example, after proceeding a while we could utilize a duration button to see how each group proceeds in the process in how many minutes.

S3. … Conducting some activities during the course such as simple competitions may be useful for enabling all group members to participate. They may have a tendency to finish the activity quickly and to get the incentive reward.

When the participants' suggestions for promoting the implementation process were evaluated, competition that cannot attain higher levels and corroboration of competition with minimal incentives became obvious. It is possible to state that the usage of factors that will support intergroup competition at the entertainment level can make the implementation more entertaining. In addition, providing preservice teachers with concrete models of real-life problems can be effective in stimulating participant motivations.

Discussion and Conclusion

The research results include various negative opinions in addition to positive feedback. It was stated by the pre-service teachers that there are some negative implications for freshmen in the process of skipping the steps in solving real-life problems or strengthening their mathematical literacy because of the fact that they are studying similar subjects with a different model after they have passed a new placement test. For the experimental study to proceed properly, as a prerequisite, the preservice teachers must watch the videos sent to them before the courses. Here, it is notable that the video duration suggested by the participants was approximately seven minutes, providing the whole subject was lectured on. Similarly, McGivney-Burelle and Xue (2013) suggested the appropriate duration for videos as approximately five minutes. Notably, instead of social networks or learning management systems, the "WhatsApp" application, which is a frequently used instant messaging service, was the preferred mobile learning environment, because students were able to watch the course videos without being in need of redownloading them, and they could use their smartphones to study without any location or time limitations. Johnston (2017) and Sahin, Cavlazoglu and Zeytuncu (2015) similarly noted the time and location flexibility enabled by the videos. Although it was expressed only by one participant under the preliminary preparation theme, another notable positive effect is that watching the course videos before the in-class lecture has a positive effect on learner responsibility. As stated by Jungic, Kaur, Mulholland and Xin (2015), the flipped classroom model encourages students to participate in the process actively before and during the course.

The in-class activities that comprise a significant aspect of the flipped classroom model also generate the significant outcomes of this research. The in-class activities that provide a basis for the teamwork process and consist of real-life problems enabled the participants to regard themselves as active learners. The participants' opinions showed that the teamwork processes play a vital role in forming the perception of an "entertaining mathematics course". It is believed that the equality of opportunity, the effective discussion environment, and the cooperation developed for solving the problem that each of the preservice teachers have facilitate peer learning. Lesseig and Krauss (2017) indicated that the factor that lies at the center of the flipped classroom model is the enriched time spent in class through the cooperative learning activities conducted among small groups. Ziegelmeier and Topaz (2015) mentioned that the discussions among the students build a community of learning. Guerrero, Beal, Lamb, Sonderegger and Baumgartel (2015) pointed out to the flipped learning's positive contribution to the attitudes towards mathematics since it enables more student-centered activities and problem-solving. Murpy, Chang and Suaray (2016) reported a similar result related to a positive change in the students' attitudes and thoughts towards mathematics. Furthermore, the participants' views indicating that the sense of belonging also developed besides the peer learning suggest that there were positive affective behaviors in

addition to the academic contribution. Another result is the pleasure of achievement that the students felt after the in-class activities. It was observed that the pleasure of achievement students felt after solving real-life problems in an entertaining manner as a group had a positive effect on the students' motivation. Another matter that affected motivation was the "usage of knowledge in real life". The positive effect of flipped classroom model on the students' motivation is in accordance with the research findings of Bhagat, Chang and Chang (2016).

Another important finding from the focus group discussions was the professional development theme. This theme provides an evidence that the experimental study conducted resulted in an outcome similar to the Teaching Methods course. Thus, the freshmen opinions are the most significant result of this research. Through the field instruction, the acquisition of the field efficacies was defined; through the skills, the 21st Century Skills such as critical thinking and showing patience were noted. Wright (2015) reported the improvement in the students' knowledge and understanding levels for not only linear algebra but also for all branches of mathematics. The professional teaching knowledge notes that the preservice teachers began to observe the Academician in charge as a role model. It is believed that this finding assigns a different meaning to the experimental study since the teachers used the concepts of concrete operations and storifying by referring to the age range and characteristics of their preservice students. At the end of the research conducted with the students of Faculty of Education, Al-Zahrani (2015) indicated that a well-designed flipped classroom will motivate college students to generate specific ideas on the real-life problems.

At the end of the implementation that begins with qualification expectations and question marks, the opinions indicated that the Mathematics course was entertaining for the first time and it answers the question regarding what mathematics knowledge should do in our daily lives; this is an indicator that an important prejudice was overcome. Although certain students indicated that they continued to dislike mathematics courses, at the end of the experimental study by Ogden (2015), they also declared that they were no longer afraid of mathematics and were felt skilled more. It appears that there was healthy peer-to-peer communication and student-academician communication; these are considered factors that played a significant role in overcoming this prejudice. This finding is in accordance with the research conducted by Anderson and Brennan (2015) and Ziegelmeier and Topaz (2015). However, slight failure in communication, which was also noted by the researchers, was criticized by the participants.

When the preservice teachers' suggestions for developing the implementation were requested in the last focus group discussion question, the teachers suggested organizing competitions in which the competitive level is not increased and the process becomes more entertaining and motivating. Another suggestion was to provide incentive rewards such as candies or chocolates at the end of these time-limited competitions. Another suggestion that is thought to increase motivation is the request of the videos to be used in the flipped classroom applications to be shot by the responsible lecturer of the course. Students expect the process to be fun. It is thought that the competitions to be held or the chocolate to be distributed will increase the motivation. The point to be considered here is the use of external motivational elements. It is important not to drift apart the process as a result of the competitions to be held. The research results show similarities between the flipped classroom model's positive effects in terms of motivation, participation and interaction and the 28 research studies that were conducted until the end of 2014 and analyzed by O'Flaherty and Phillips (2015) and the 20 research studies that were conducted between 2013-2015 and analyzed by Zainuddin and Halili (2016). It is believed that this model in which the learner is at the center can make significant contributions to the acquisition of 21st century skills. Further research, with the objective of justifying or developing this idea, in which gamification items are used or environments enriched with virtual reality applications can be performed. Consequently, conducting similar research over several courses and at various course levels should make contributions to the field.

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