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Flipped classroom in higher education: An investigation of instructor perceptions through the lens of TPACK

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Abstract

This study was carried out by using the nested single case study design, which is a qualitative case study method, in order to determine the experiences and thoughts of the instructors about the flipped classroom method. The experiences of the instructors related to the flipped classroom were examined within the framework of Technological Pedagogical and Content Knowledge (TPACK). The study group of the research consisted of instructors working at a state university in Turkey, and taking part in 4 different departments determined by purposive sampling. Five instructors were interviewed, and one instructor's lesson was observed. The data were collected through a semi-structured interview form and observation form developed by the researchers. Content analysis method was used in the data analysis. The definitions of the flipped classroom, the technologies used in the flipped classroom, the effects of the flipped classroom on students, the difficulties encountered in the flipped classroom, and the themes and sub-themes for making the flipped classroom more effective were determined as a result of the interviews with the instructors. There were various positive and negative opinions of the participants under each topic. According to the results of the study, TPACK-related competencies of the instructors in integrating technology into learning environments also had an important place in the development or provision of course materials as well as the use of these materials in the flipped classroom.

Keywords Flipped classroom · Flipped learning · Technological pedagogical content knowledge · TPACK · Learning environment

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1 Introduction

The importance of student-centered learning and teaching processes were highlighted in the studies on effective learning (Brouwer et al., 2019; Brown, 2003; Kulakow & Raufelder, 2020; Lee & Hannafin, 2016; Wang & Zhang, 2019). In this sense, especially in recent years, learning environments have started to transform into a structure, where students actively participate and assume their own learning responsibilities. Technological developments too have an effect on this transformation significantly (Chen & Tsai, 2021; Gauci et al., 2009; Pourhosein-Gilakjani & Rahimy, 2020). Technology has changed the mindset of teaching and learning as a whole, not merely learning environments, and learning contents. Consequently, teachers' and students' roles in learning environments have changed over time. Instead of simply transferring knowledge into the classroom, teachers are now assuming an active role in guiding students, enabling them to get access to knowledge and to configure the obtained information within the framework of their own lives, while students are taking their own responsibilities in the learning process, searching, utilizing information, studying collaboratively, and solving problems (Freeman et al., 2014; Tobiason, 2021; Yoder et al., 2021).

Since traditional learning methods represent a more teacher-centered structure, recently, student-centered novel learning methods have been widely mentioned in the literature. The flipped classroom is one of these new methods discussed in the literature. The flipped classroom is the reverse of the traditional classroom, offering a student-centered learning approach where they can actively participate in the learning process (Kushairi & Ahmi, 2021; Piotrowski & Witte, 2016; Saab & Stengs, 2014). In the flipped classroom, having studied the course materials (videos, presentations, readings, etc.) prepared and shared by the teachers in advance, students come to the lesson already prepared at home, and in the classroom environment, however, they experience active learning activities such as problem-solving, collaborative study, and classroom discussions under the guidance of the teacher (Bergmann & Sams, 2012; Nouri, 2016). It is possible to carry out in-class and out-of-class activities effectively and efficiently in the flipped classroom, provided that teachers have sufficient knowledge, skills, and competencies (Cox, 2008; Limniou et al., 2018; McLaughlin et al., 2014; O'Flaherty & Phillips, 2015; Piotrowski & Witte, 2016). In this respect, the prominent qualification teachers should have in the flipped classroom method management is the capability to use information and communication technologies in education, particularly for the preparation of out-of-class activities.

Learning outcomes are significantly affected if the teachers appropriately integrate technology into the learning-teaching processes (Angeli & Valanides, 2009; Cheng et al., 2020, 2021; Niess, 2005; Tondeur et al., 2012). The Technology Pedagogy and Content Knowledge (TPACK) is used to examine the technology integration knowledge of teachers. TPACK covers the entire technology integration process while assessing teachers' knowledge, skills, and competencies, as a result, becoming a pedagogy-centered technology integration model. The main components of the TPACK model are content knowledge (CK), pedagogical

knowledge (PK), and technology knowledge (TK). CK signifies the teachers' knowledge of the subject. PK indicates the knowledge and skills required to plan, implement, and assess learning activities. However, TK involves teachers' ability to use various hardware, software, and systems (computers, mobile devices, presentation preparation software, etc.). These main components recombine to form the sub-components, namely pedagogical content knowledge (PCK), technological content knowledge (TCK), and technological pedagogical knowledge (TPK) (Koehler & Mishra, 2005, 2009; Mishra & Koehler, 2006). PCK guides the teacher in selecting the appropriate learning method to teach a concept. TCK involves using technology to follow the latest developments in a field of content. On the other hand, TPK refers to using technology in learning processes to carry out learning activities. Since TPACK is the intersection of these knowledge types (PCK, TCK, and TPK), teachers must have a comprehensive knowledge of all the components in order to be able to integrate technology effectively into the education process. In conclusion, teachers should not only benefit from educational technologies while preparing course materials in the flipped classroom method, but they should also integrate these technologies into their teaching processes.

2 Purpose and importance of research

The flipped classroom method has been used in many different disciplines, such as foreign language, mathematics, health, information technologies, and engineering education. Many positive aspects of the flipped classroom have been mentioned, such as reducing the anxiety level of students, active learning, increasing the permanence of learning, and improving problem-solving and questioning skills (Hsia et al., 2021; Kim et al., 2014; Kushairi & Ahmi, 2021; Özbay & Çınar, 2021; Pierce & Fox, 2012; Strayer, 2012), in addition to various negative aspects, including difficulty in finding or developing appropriate educational materials, and deprivation of some of the benefits provided by face-to-face education (Enfield, 2013; Milman, 2012). Despite some drawbacks, the benefits increased interest in the flipped classroom. However, the studies generally focused on the student and content, whereas very few studies focused on the teacher (Jwaifell et al., 2018; Long et al., 2016; Shaffer, 2016). In the flipped classroom method, teachers have an important role in planning in-class and out-of-class activities, creating course materials, and guiding students at every stage of the courses. At the same time, teachers need to integrate technology into their teaching processes appropriately in order to make flipped classrooms effective (Davies et al., 2013; Kushairi & Ahmi, 2021; Saab & Stengs, 2014). Therefore, it is considered that investigating the experiences and thoughts of instructors in higher education about the flipped classroom will make significant contributions to improving the effectiveness of flipped classroom practices.

In this study, it was aimed to examine the experiences and thoughts of the instructors at a state university, who actually practiced the flipped classroom method. In this context, answers to the following research questions were sought:

1. How do the instructors describe the flipped classroom method in relation to their experiences?
2. What are the technologies used by the instructors in the flipped classroom method?
3. According to the instructors, what are the effects of the flipped classroom method on students?
4. What are the challenges encountered by the instructors concerning the flipped classroom method?
5. What are the opinions and suggestions of the instructors about making the flipped classroom method more efficient?

3 Methodology

In this section, the main procedures that were followed in carrying out the current study are described.

3.1 Design and procedure

This research was carried out with a nested single-case design, which is a case study design and one of the qualitative research methods. Case study is a research method in which a case is considered within its real-life context; the cases are analyzed in a multi-dimensional approach and in-depth, and at the end of this analysis, case-related themes are defined (Creswell, 2013; Yıldırım & Şimşek, 2013; Yin, 2015). The nested single-case design, amongst the case study types, is used in the case of examining a case containing one single unit of analysis (Yin, 2015).

The purpose of using qualitative research in this study is to gain a comprehensive grasp of the flipped classroom method. Furthermore, employing the qualitative research approach is critical for fully explaining and describing the flipped classroom method under inquiry in its natural setting. This study was carried out in the academic year of 2018–2019. The unit of analysis in the present study was a state university in Turkey. The case explored was the experiences and thoughts of the instructors in this analysis unit who experienced teaching with the flipped classroom method. In this regard, the statements of the instructors reflecting their experiences and thoughts about the flipped classroom method were examined in depth.

3.2 Participants

Five instructors working at a state university constituted the study group of the research. The participants included in the study were selected by the purposive sampling method. The purposive sampling method was used in the process to make sure that the sample would be information-rich individuals who are deemed to be knowledgeable in the area under study (Fraenkel et al., 2012). The inclusion of the participants was based on one criterion: instructors who had experience teaching with the flipped classroom method before. Therefore, the instructors who have used

the flipped classroom method in their classes at the relevant state university were included in the sample. Face-to-face interviews were held with five instructors. Furthermore, direct observation was made during the lessons of one of these instructors.

Scientific research should include a set of quality assurance norms (Petousi & Sifaki, 2020). Ethical considerations of these are very important for any research. Findings obtained from data collected through interviews in qualitative research should clearly describe the experiences and perceptions of the participants. Participants can share personal and intimate information about their lives depending on the topic studied and research questions. These may include socially undesirable experiences such as procrastination, addiction, fear, and anxiety. Therefore, there are ethical responsibilities in terms of personal or institutional privacy in the reporting of findings (Hammersley & Traianou, 2012). It is particularly important to protect the privacy and confidentiality of participants. For this reason, participant names were coded in this study. The names of the participants were coded as P1, P2, P3, P4, and P5. Direct quotations from the statements of the instructors were shared by using these codes. Demographic information about the participants is presented in Table 1.

Among the participants, four of the instructors were male and one was female. They were all working in four different departments, in two different faculties, with different areas of expertise and experience.

3.3 Data collection tools

Two data collection tools were used in the study. One of them was the semi-structured interview form developed by the researchers. The other was an observation form, also developed by the researchers. Five instructors who have used the flipped classroom method in their classes were interviewed during the data collection process. Furthermore, an observation was made in the lesson of one of these instructors, who was currently using the flipped classroom.

3.4 Semi-structured interview form

The semi-structured interview form was one of the data collection tools used in the study. The form's goal is to gather detailed information about the flipped classroom

Table 1 Distribution of participants' demographic information

Code	Gender	Academic Title	Faculty	Department
P1	Male	Prof. Dr	Engineering	Materials Science and Nanotechnology Engineering
P2	Male	Asst. Prof. Dr	Engineering	Mechanical Engineering
P3	Female	Instructor Dr	Educational Sciences	English Language Teaching
P4	Male	Instructor	Engineering	Materials Science and Nanotechnology Engineering
P5	Male	Instructor	Engineering	Computer Engineering

Table 2 Interview questions

Question Number	Interview Question
1	How would you describe the flipped classroom, considering your own experiences?
2	What kind of technologies do you use while creating course materials in the flipped classroom method?
3	What kind of technologies do you use for sharing course materials in the flipped classroom method?
4	What kind of effects do you think the flipped classroom method has on students?
5	What kind of problems did you encounter while using the flipped classroom method?
6	What are your opinions and suggestions to make the flipped learning method more efficient?

Table 3 Distribution of the participants and the duration of interview

Code	Duration of the Interview
P1	30 min
P2	32 min
P3	35 min
P4	37 min
P5	45 min

from instructors based on their experiences and thoughts. The questions in this interview form were developed by the two researchers who conducted the study. The questions were then reviewed by an expert in the relevant field. Following that, a pilot study was conducted, and flaws were identified and eliminated through an iterative consultation process whereby the researchers solicited advice from an expert.

Using the semi-structured interview form, face-to-face interviews were conducted with 5 instructors who have used the flipped classroom method in their classes before. In addition to these already prepared questions, probing questions were asked during the interviews whenever necessary, in order to explore the statements of the participants in-depth. Also, a personal information form was developed by two researchers and used to obtain the demographic information of the instructors. The interviews were conducted by two researchers. The questions of the semi-structured interview form are presented in Table 2.

Interviews were carried out with five instructors who have used the flipped classroom method in their classes and agreed to participate in the research, at the university where the research was conducted. With regard to ethical considerations, informed consent forms were given to the instructors with the necessary explanations to be signed by them. The date and time of the interviews were scheduled based on the availability of the instructors for the interviews. Furthermore, the interviews were held in a meeting room where they would not be interrupted and where the interviews could be carried out comfortably. Information about the interviews with the participants is presented in Table 3.

Interviews lasted between 30 and 45 min. The participants did not give consent for tape recording. Therefore, the interviews were recorded instantaneously by two researchers by taking notes on the semi-structured interview form.

3.5 Observation form

The second data collection tool used in the study was the observation form, which was developed by two researchers who conducted the study. This form was then examined by an expert in the related field. Afterward, a pilot application was held, deficiencies were determined and corrected by taking expert opinion again, and the form was finalized. Non-participant observation was made during the study. With respect to non-participant observation, it was expected that from observation the researchers would be able to identify how the flipped classroom was integrated into the lesson and the experiences of the instructor and students involved. Information about the participant who was observed throughout his class is presented in Table 4.

The instructor observed during his lesson was from the Department of Materials Science and Nanotechnology Engineering. He used the flipped classroom method for the Polymer Science and Technology course, which was 3 h a week. At the time of our observation, the subject was "Composites". Necessary permission for observation was obtained from the instructor in advance. We were present in the classroom for observation at the time of the lesson. The instructor and students were observed for 3 h by two researchers trained and experienced in the flipped classroom.

3.6 Data analysis

The data concerning the semi-structured interview form and the observation form were analyzed by content analysis through NVivo version 12. In content analysis, the objective is to attain the concepts and relationships that can explain the collected data (Yıldırım & Şimşek, 2013). Creswell's (2013) data analysis process was followed to analyze the study data. The data analysis process is presented in Fig. 1.

According to the data analysis process summarized in Fig. 1, all of the data recorded for analysis was first transferred to the digital environment, then analyzed and coded separately by two researchers. Afterward, the researchers compared the similarities and differences in the codes and came to an agreement regarding the codes. Inter-rater reliability was calculated using the formula "reliability = [agreement / (agreement + disagreement)] * 100" (Miles & Huberman, 1994). Inter-rater reliability values between the researchers are presented in Table 5.

Themes were obtained from the codes, taking the literature into account. During the analysis, attention was paid to ensure that the themes constitute a meaningful whole

Table 4 Observation data for the class of Participant 1

Code Name	Course	Subject	Observation Length
P1	Polymer Science and Technology	Composites	180 min

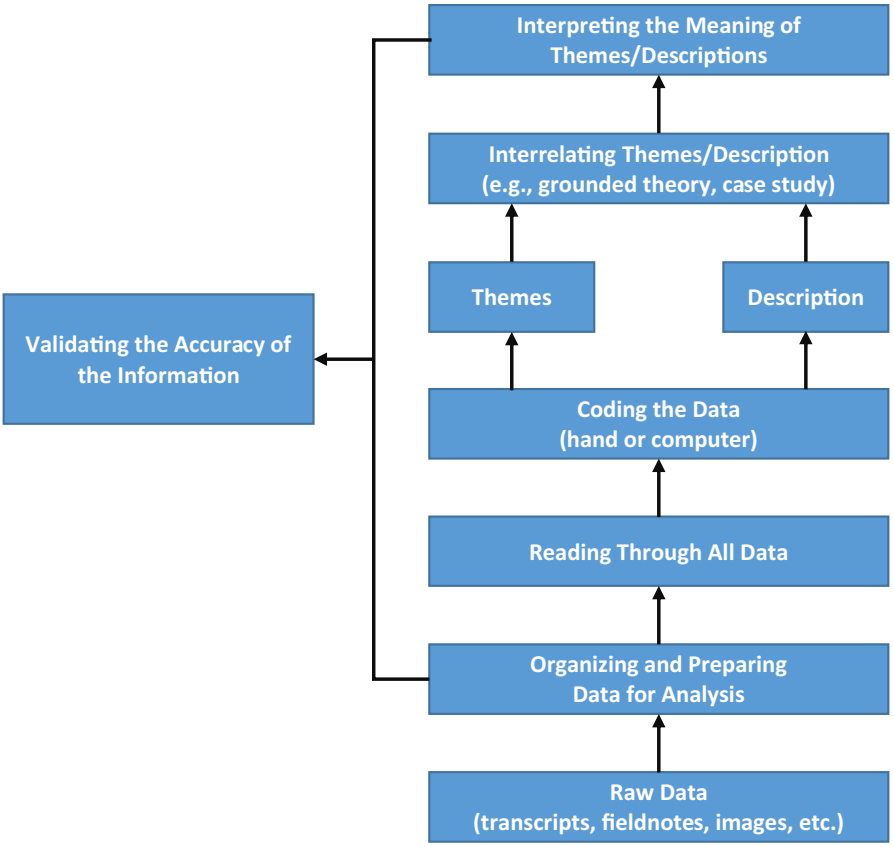

Fig. 1 Steps of the data analysis process

Table 5 Distribution of inter-rater reliability values

Theme	Number of Codes with Agreement	Number of Codes with Disagreement	Reliability Value (%)
Definition of the Flipped Classroom Method	7	2	77.78
Technologies Used in the Flipped Classroom Method	12	2	85.71
Positive Effects of the Flipped Classroom Method on Students	9	3	75.00
Negative Effects of the Flipped Classroom Method on Students	13	2	86.67
Challenges Confronted in the Flipped Classroom Method	15	1	93.75
Making the Flipped Classroom Method More Efficient	11	2	84.62

within themselves as well as provide unity among themselves, reflecting the entire concept map. The obtained findings related to the themes were interpreted by the researchers, and direct quotations from the participants were included where necessary. All interviews were conducted in Turkish, but direct quotations in the study were translated into English by the researchers. Then a language expert critically reflected on the translations to ensure that the meanings of the quotations were maintained and that possible misunderstandings were avoided. Furthermore, observation was made during the lessons of one of these instructors, and inter-rater reliability values between the researchers was 80.00% for observation data (Number of codes with agreement = 8, Number of codes with disagreement = 2).

3.7 Validity and reliability of the study

In qualitative studies, validity is described as the confirmability of research results, while reliability is defined as the consistency of the study design in different studies. In this regard, in order to ensure the validity and reliability of the study, the following criteria were used: credibility for internal validity, transferability for external validity, consistency for internal reliability, and confirmability for external reliability (Creswell & Miller, 2000; Lincoln & Guba, 1985; Yıldırım & Şimşek, 2013).

The researchers tried their best to be unbiased while taking the participants' statements, in order to establish credibility that ensures internal validity. Participant's confirmation was requested during the interviews, whenever needed, to avoid misunderstandings. A detailed reporting was applied for transferability, which ensures external validity. Furthermore, the study group determined by the purposive sampling method was introduced in detail.

The researchers asked questions to each participant with a similar approach and took notes during the semi-structured interviews, for the consistency that ensures internal reliability. Direct quotations of the participants were included wherever relevant while presenting the findings. The findings obtained were reported by the researchers in a clear and comprehensible way, for confirmability that ensures external reliability. In addition, the study findings were compared with similar research findings in the literature and discussed.

The researchers did their utmost to remain objective when recording the statements of the participants in order to establish credibility and maintain internal validity. There was triangulation, peer assessment of the findings, an attempt to involve people in the entire process, and the researchers were cautious to remain unbiased (Merriam, 1998). Observation allows for the determination of activities or situations that have not been mentioned in the interview and thus can be used to enhance the information obtained from the interview. As a result, researchers used triangulations to assure validity while collecting data through non-participant observation and interviews. The key reason for triangulating the data was to double-check and collect valid, unbiased, and reliable information that was pertinent to the study's research objectives. Also, to ensure the reliability of the findings, researchers held meetings to check that the results and conclusions matched.

4 Results

In this section, the data obtained from the observation and interviews were transformed into concepts and themes by means of content analysis. The findings of the research are explained according to the themes determined as a result of the data analysis within the framework of research questions. The definition of the flipped classroom method, the technologies used in the flipped classroom method, the effects of the flipped classroom method on students, challenges confronted in the flipped classroom method, making the flipped classroom method more efficient, and observation findings are all shared in the following order.

4.1 Definition of the flipped classroom method

The first research question was specified as “How do the instructors describe the flipped classroom method in relation to their experiences?”. In this regard, the question of “How would you describe the flipped classroom, considering your own experiences?” was addressed to the participants during the interviews.

The flipped classroom definitions of the participants were grouped under 3 themes: "Student", "Learning environment", and "Technology". The themes obtained by analyzing the participants’ flipped classroom definitions are presented in Fig. 2.

While defining the flipped classroom method, the participants underlined the points of getting prepared before the class, supporting active participation and learning in the student dimension; time and space independence in the learning environment dimension, and the technological infrastructure used for creating and sharing

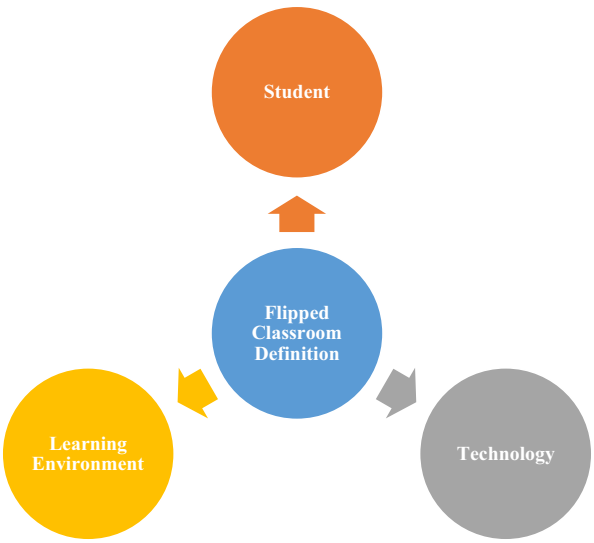

Fig. 2 The themes obtained from the participants’ flipped classroom definitions

course materials in the technology dimension. The participants also pointed out that materials could be useful for understanding the subject; learners could review materials over and over again. Some of the quotations directly taken from the participants' statements are given below.

> *"It is a more convenient learning method for current times with respect to traditional methods, involving learning anywhere and anytime, without entering the classroom environment, and it will have an important place in the future (P1)."*
> *"It is a learning method that ensures students come to the class prepared in advance, almost obligating students' active participation in the class, helping them to be more conscious and facilitating the course (P4)."*

P1 expressed the flipped classroom method as an innovative learning method that allows students to learn the content with the help of technology-based tools without gathering in a physical classroom environment. Also, P4 stated that the out-of-class activities practiced in the flipped classroom method ensure students' coming to class prepared, and have a significant role in their active participation in the lesson.

4.2 Technologies used in the flipped classroom method

The second research question of this study was decided as "What are the technologies used by the instructors in the flipped classroom method?". In this respect, the questions "What kind of technologies do you use while creating course materials in the flipped classroom method?" and "What kind of technologies do you use for sharing course materials in the flipped classroom method?" were posed to the participants in the interviews. The technologies used by the participants in the flipped classroom method were grouped under two themes: "Creating course materials" and "Sharing course materials". The technologies used by the participants in the flipped classroom method are presented in Table 6.

Participants used electronic book preparation software, presentation preparation software, video creation software, and word processing software in the creation of course materials, while e-mails, cloud servers, learning management systems, and video sharing sites were used for the sharing of course materials. Participants mostly preferred to create course materials as videos and share them through learning management systems.

Table 6 Distribution of Technologies used by participants in the flipped classroom method

Technologies Used in the Flipped Classroom Method	
Creating Course Materials	Sharing Course Materials
Electronic Book Preparation Software	E-mail
Presentation Preparation Software	Cloud Servers
Video Creation Software	Learning Management Systems
Word Processing Software	Video Sharing Sites

4.3 The effects of the flipped classroom method on students

“According to the instructors, what are the effects of the flipped classroom method on students?” was the third research question. In this regard, “What kind of effects do you think the flipped classroom method has on students?” was directed to the participants. The data obtained from the interviews was analyzed under two headings: "Positive effects of the flipped classroom on students" and "Negative effects of the flipped classroom on students".

4.4 Positive effects of the flipped classroom on students

The positive effects of the flipped classroom on students were grouped under 4 themes: "Motivation", "Academic success", "Self-regulation", and "Attitude" as a result of the interviews with the participants in the context of the third research question of the study, as shown in Fig. 3.

The participants identified the positive effects of the flipped classroom on students as increasing motivation, positively affecting academic success, improving self-regulation skills, and developing a positive attitude towards the course. Moreover, the participants stated that students have positive perceptions of the lesson and a high level of satisfaction with the classroom environment. The positive classroom environment created by the flipped classroom method encourages students to participate in classroom interactions and to work collaboratively. Some of the direct quotations from the statements of the participants were as follows:

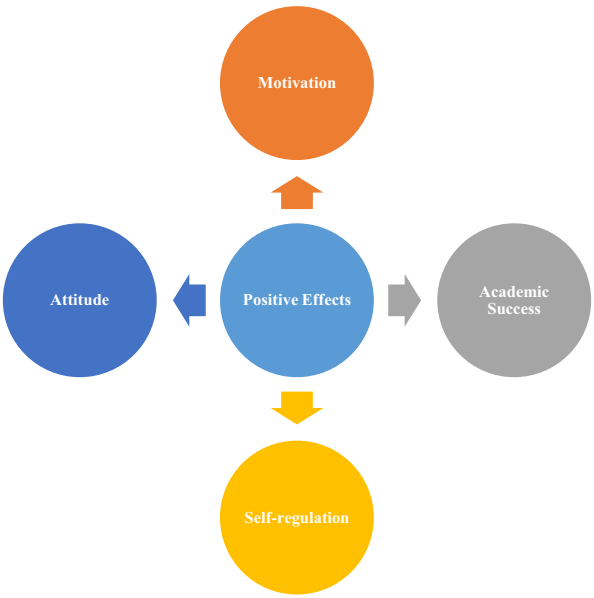

Fig. 3 Positive effects of the flipped classroom on students

"Accessing the course materials whenever and wherever they want provides a great advantage for the students. They achieved the best success in the course by repeating these materials freely whenever they wanted (P2)."
"The new education system is not on paper; we need modern methods to keep up with the times. The flipped classroom method provides this. I share course materials with students via the internet so that they can access them whenever they want. There are also many in-class practices that increase students' motivation (P3)."

P2 stated that the flipped classroom method provided flexibility to students and positively affected their academic success due to the availability of the course materials whenever and wherever they wanted. Similarly, participant P3 expressed the important role of the flipped classroom in keeping up with the change in education, providing a learner-centered, practice-oriented education instead of traditional teacher-centered instruction, which increases students' motivation.

4.5 Negative effects of the flipped classroom on students

As a result of the interview with the participants in the context of the third research question, the negative effects of the flipped classroom on students were gathered under 3 themes: "Motivation", "Academic success", and "Attitude" as shown in Fig. 4.

Participants stated the negative effects of the flipped classroom on students as reducing motivation, negatively affecting academic success, and developing a negative attitude towards the course. In addition, the participants stated that the increased workload of the students in the flipped classroom method revealed these negative

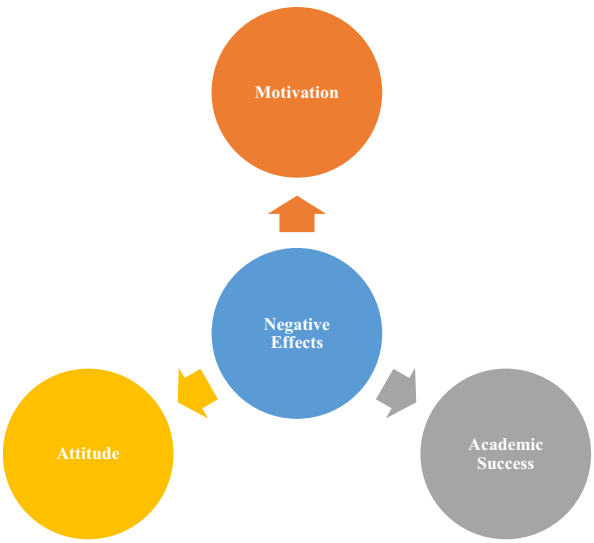

Fig. 4 Negative effects of the flipped classroom on students

effects. Some of the direct quotations from the statements of the participants are given below:

"It had negative effects on the students who did not review the shared materials or watch the videos before attending the class; they had difficulty understanding the topic of the lesson and participating in the classroom activities that day (P1)."
"Students occasionally had difficulty following the out-of-class activities because it was a new method that students were not accustomed to. So, they could not catch up with the lesson and eventually developed a negative attitude towards the course. Sometimes, connection problems occurring due to technological infrastructure might also affect students' motivation negatively (P5)."

P1 stated that the students who failed to follow the course materials shared for out-of-class activities had difficulties participating in the classroom activities, hence their academic success could be negatively affected. P5, however, pointed out that the students were not familiar with the flipped classroom, so they developed a negative attitude towards the course, and the internet disruptions caused by the technological infrastructure negatively affected the students' motivation.

4.6 Challenges confronted in the flipped classroom method

The fourth research question of this study was decided as "What are the challenges encountered by the instructors concerning the flipped classroom method?". In this respect, the question of "What kind of problems did you encounter while using the flipped classroom method?" was posed to the participants in the interviews.

The challenges of a flipped classroom were grouped under 5 themes: "Learning environment", "Technological infrastructure", "Attitude", "Self-regulation" and "Course material", as shown in Fig. 5.

Participants pointed out the difficulties they encountered in establishing an appropriate learning environment for in-class activities, such as inadequacy of technological infrastructure and technology-related problems, resistance arising from negative attitudes towards the course, students with low self-regulation skills being unable to follow out-of-class activities, and time-consuming efforts in creating or finding appropriate course materials. The participants were also concerned about how much time and effort they would have to spend when they could not get technical support to design a quality course using the flipped classroom method. Some of the direct quotations from the statements of the participants were as follows:

"Because it is a new method for students, they show resistance to this method. Students had difficulty getting used to this learning method (P1)."
"Some problems related to problems in technological infrastructure have an adverse effect on sharing the course materials and performing classroom activities. The flipped classroom method requires good technical support (P3)."
"It is quite time-consuming to conduct the lessons with the flipped classroom, although it is an effective method. Because I have to prepare the course mate-

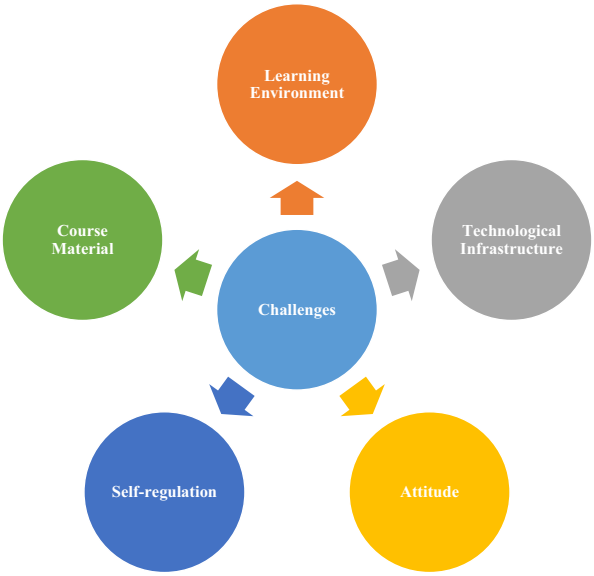

Fig. 5 Challenges confronted in the flipped classroom

rials for the students at home on a weekly basis, it is also very troublesome to plan in-class activities (P4).”

P1 remarked that students developed negative attitudes and showed opposition to the course because the flipped classroom was an unfamiliar new method for them. P3 pointed out that technological infrastructure issues were negatively affecting learning activities. On the other hand, the flipped classroom method was evaluated as a very time-consuming method by P4.

4.7 Making the flipped classroom method more efficient

The fifth research question of this study was “What are the opinions and suggestions of the instructors about making the flipped classroom method more efficient?” In order to find an answer to this question, “What are your opinions and suggestions to make the flipped learning method more efficient?” was directed to the participants.

Instructors’ opinions and suggestions concerning this issue were grouped under 3 themes: "Learning environment", "Technological infrastructure", and "Course material", as shown in Fig. 6.

Participants suggested that there should be suitable learning environments for in-class activities, adequate technological infrastructure and proficient technical support to solve the potential problems that can occur on the technological side, competent training for the creation of course materials, and qualified professional support. This may lead to a decrease in the workload of the instructors. Some of the direct quotations from the statements of the participants are given below.

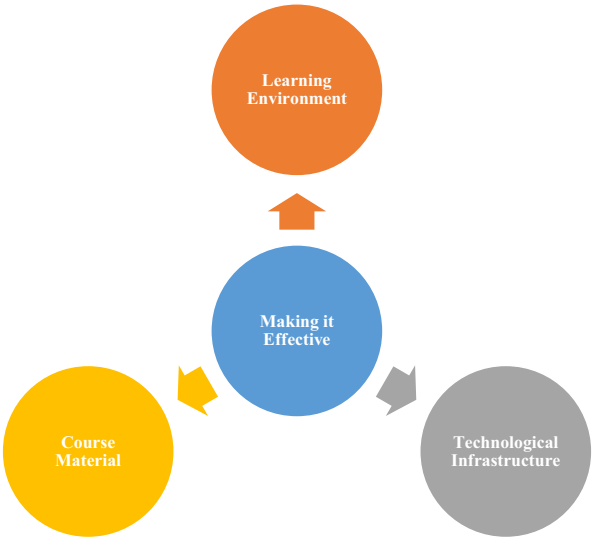

Fig. 6 Instructors' opinions and suggestions on making the flipped classroom more efficient

> *"It is not difficult to perform out-of-class activities, once the fundamental technological infrastructure is provided. However, the classroom environment needs to be set up to accommodate the in-class activity to be performed. Sometimes the classroom environment does not meet the requirements. In my opinion, one of the most important issues concerning the flipped classroom method is having an adequate classroom environment for in-class activities (P2)."*
> *"In-service training should be organized for instructors on providing and developing course materials. We do not know how to manage, although we want to prepare various materials. Diverse digital materials should be obtained, and even if some programs need to be paid for, they should be purchased by the institution and provided to the instructors to be used in the education process (P5)."*

P2 expressed that the learning environment should be adequate for in-class activities of the flipped classroom. A need was highlighted by the participant coded P5 regarding training the instructors in creating learning materials for out-of-class activities and providing professional support.

4.8 Observation findings

The observation was made by the researchers during the three hours of the "Composites" lesson of the Polymer Science and Technology course, performed by P1 working in the Materials Science and Nanotechnology Engineering department, following the flipped classroom method. The observation form, prepared by the researchers during the observation process, was taken into account. It was aimed at explaining or supporting the interview data with the observation data. The data

obtained as a result of the observation were recorded in these observation forms. Table 7 shows the themes obtained from the observation data.

The observation results are clearly consistent with the interview results described in the previous section. As a result of the observation, it was determined that the learning environment was not suitable for the topic covered that week, so in-class activities could not be implemented effectively. The course materials were used for the purpose of teaching the subject of that week. These materials were then used to support in-class activities. In-class activities were based on discussion, problem-solving, and teamwork. Active participation of the students in the courses increased the students' motivation.

5 Discussion

Studies about the flipped classroom method reveal that this method can contribute to active participation in the lesson, encourage collaborative learning, increase motivation, improve problem-solving and high-level thinking skills, increase the interaction of the student with the teacher and the other students, and positively affect learning (Albert & Beatty, 2014; Hinojo Lucena et al., 2020; Kim et al., 2014; Özbay & Sarıca, 2019; Pierce & Fox, 2012; Strayer, 2012). In most of these studies, however, the reported results were based on the data obtained from the students. In this regard, studies supporting these results with the data obtained from teachers are still considered insufficient (Jwaifell et al., 2018; Long et al., 2016; Shaffer, 2016). In order to fill the gap in the literature, this present study, in contrast with the other studies, examined the flipped classroom method from the instructors' point of view with a critical approach.

The results of the present study have brought a new perspective to the research about the flipped classroom method from the point of view of the instructors in the context of TPACK. The results from the interviews and observation data are discussed in more detail below in the context of TPACK. Instructors who can integrate the relationship between technology, pedagogy, and content can reach a level of expertise that goes beyond their own field knowledge (Koehler & Mishra, 2009). This integrated knowledge supports the process of understanding technology in the context of pedagogy and content (Benson & Ward, 2013).

Within the scope of the research, it was first aimed to reveal how the instructors defined the flipped classroom according to their own experiences. The instructors' experiences and descriptions were attempted to be comprehended about the

Table 7 Themes obtained from the observation data

Themes
Learning environment
Course material
In-class activities
Motivation

flipped classroom within the context of TPACK. How the instructors define the flipped classroom method manifests their flipped classroom perceptions. Eventually, the themes of "Student", "Learning environment", and "Technology" were obtained from definitions of the flipped classroom expressed by the instructors. The instructors highlighted the points of coming to class prepared in advance, active participation and supporting learning in the dimension of students, time and space independence in the dimension of the learning environment, and the technological infrastructure used in the creation and sharing of course materials in the technology dimension. This finding was related to the technological pedagogical knowledge dimension of TPACK. Instructors' technological pedagogical knowledge dimension refers to their ability to understand information and communication technology and to apply this knowledge in relevant and harmonious ways in the classroom (Koehler & Mishra, 2009). It is important for instructors to have sufficient technological pedagogical knowledge in order to manage the learning process in applications that require technology integration, such as flipped classroom methods. (Foulger et al., 2015). Moreover, the flipped classroom method allows students to have autonomous learning. It is especially important for slow learners or low achievers because they can control their learning and can study learning materials again and again until they have comprehended the lesson content (Mok, 2014; Yang & Chen, 2020). Considering the flipped classroom definitions in the literature, there are some overlapping dimensions with the definitions of our participants (Baker, 2000; Bergmann & Sams, 2012).

The technologies used by the instructors in the flipped classroom method were grouped under two themes: "Creating course materials" and "Sharing course materials". Also, some of the instructors expressed a lack of confidence in their own ability to handle the technology. The technology dimension of the flipped classroom, an innovative application, is important for the instructors. In this respect, the learning environment should be designed in accordance with the level of technology. At this point, the instructors' enthusiasm to integrate and use technology effectively in their lessons becomes prominent. This is correlated with the perceived usefulness of the technology (Davis, 1989; Ertmer, 2005; Ottenbreit-Leftwich et al., 2010). The instructors are determined to integrate technology into their learning environments, based on their perceived benefits and encountered challenges. Indeed, the attitude towards technology was previously stated in the literature to be important for technology integration (Ertmer et al., 2012; Shaffer, 2016). Technology-related benefits and the conformity of technology to the course content were reported in the literature as important factors influencing instructors' preferences for using technology in their lessons (Long et al., 2016). In addition, instructors must have comprehensive knowledge of all TPACK components to enable effective technology integration into the education process. The researchers can state that the instructors had low proficiency in TPACK when their experience in creating, sharing, and integrating course materials into the education process was considered. Thus, this would negatively influence the effective and efficient implementation of the flipped classroom method. Instructors require assistance in learning about new technologies, planning technology integration, and resolving issues in their student communities (Foulger et al., 2015).

The instructors emphasized that the flipped classroom had both positive and negative effects on the students. Its positive effects on students were grouped under 4 themes: "Motivation", "Academic success", "Self-regulation", and "Attitude". According to the instructors, the flipped classroom method had an important role in increasing the motivation of many students taking the course, positively affecting their academic success, improving their self-regulation skills, and developing a positive attitude towards the course. Based on both observation and interview findings, the engaging, encouraging, and interactive classroom environment of the flipped classroom method contributed to improving students' motivation levels. This finding is consistent with other flipped classroom studies showing that students increase the motivation of many students in the flipped classroom (Fautch, 2015; Mok, 2014; Vaughan, 2014). This finding was in the context of the pedagogical content knowledge dimension when assessed within the TPACK framework. Instructors have progressed to a better understanding of how this method affects curriculum and pedagogy (Foulger et al., 2015). One of the benefits of the use of the flipped classroom method is that there is an increased level of academic success. The flipped classroom method can promote students' deeper comprehension of subject content and make them successful in learning (McLaughlin et al., 2014; Yang & Chen, 2020). The results revealed that students' attitudes changed positively over time because of their satisfaction with the application of the flipped classroom method. Moreover, the results showed that the overall students' self-regulation increased over the period of the flipped classroom method. In addition, instructors stated that giving students responsibility for their learning through the flipped classroom improves their independent learning skills. Studies in the literature also support these results (Arif & Omar, 2019; Chai et al., 2010; Fu, 2013; Levin & Wadmany, 2006; Mcmahon, 2009; Sun & Wu, 2016).

The negative effects of the flipped classroom on students were grouped under 3 themes: "Motivation", "Academic success", and "Attitude". According to the instructors, the flipped classroom method can reduce the motivation of some students in the course, negatively affecting their academic success and resulting in negative attitudes towards the course. In this respect, especially those students who could not follow out-of-class activities had difficulty in participating in-class activities, which ultimately negatively affected their attitude and motivation. This shows the importance of bridging the out-of-class activities with in-class activities and maintaining a good balance between these two elements. Besides, some students may develop negative attitudes towards the course, since it is a method that the students are unfamiliar with. This might be due to the fact that particularly the technology used in out-of-class activities, was not well integrated into the learning processes or the fact that leaving the learning responsibility totally to the students could negatively affect the students' willingness to learn (Koehler & Mishra, 2009). In addition, students need to make connections between the course materials they have studied before the lessons and the activities conducted in classes (Roehl et al., 2013; Vaughan, 2014). So, they need to have reflective abilities.

The challenges encountered in the flipped classroom method were grouped under 5 themes: "Learning environment", "Technological infrastructure", "Attitude", "Self-regulation", and "Course material". These findings from the study can be expressed

as difficulties that may deter instructors from applying the flipped classroom method in their future classrooms. Difficulties in creating a suitable learning environment for in-class activities, inadequate technological infrastructure and related problems, students' resistance to the course due to negative attitudes developed, students with low self-regulation skills failing to follow out-of-class activities, and time-consuming efforts for creating or finding appropriate course materials were the main points regarding the challenges the instructors had. In the studies published so far, the primary challenge of the flipped classroom method was concluded as those students with low self-regulation skills failing to attribute importance to out-of-class activities as they should, and attending in-class activities without adequate preparation (Long et al., 2016). Hence, this negatively affects the participation expected in the in-class activities. The determination of the instructors' preference for the flipped classroom is also negatively affected due to the considerably time-consuming tasks of creating or finding the course materials as an essential part of out-of-class activities. It can be argued that a flipped classroom method inherently needs more time and effort investments (Aghaei et al., 2020). When instructors intend to add a novelty to their courses, they take into account the time and effort they will spend in comparison to its contribution to students' performance (Sales, 2010; Shaffer, 2016). Reflecting on an instructor's personal TPACK profile and understanding development can provide insight into their professional development needs and enable the instructor to look at their knowledge in these areas in a more systematic way (Benson & Ward, 2013). Creating the proper technological infrastructure and the right learning environment also has an important effect on the flipped classroom method attaining the desired learning outcomes. The instructors stated that the challenges they confronted while using the flipped classroom had a negative impact on students' learning processes and they developed a negative attitude towards the course. This situation shows the importance of controlling such difficulties. Furthermore, studies in the literature show that the incompetence of teachers in integrating technology into learning environments can negatively affect students' attitudes (Ertmer, 2005; Ertmer & Ottenbreit-Leftwich, 2013; Hermans et al., 2008). Accordingly, instructors' proficiency in TPACK gains importance in the flipped classroom.

Finally, within the scope of the research, the opinions and suggestions of the instructors were examined on how to make the flipped classroom method more efficient. The opinions and suggestions of the instructors about making the flipped classroom method more effective were grouped under 3 themes: "Learning environment", "Technological infrastructure", and "Course material". Instructors suggest having the right learning environment for in-class activities, having adequate technological infrastructure, providing technical support to eliminate technology-related problems, providing training for creating course materials, and providing professional support are all recommended. A significant amount of time, effort, and resources are required for student-centered learning methods using technology, such as the flipped classroom method, where active student participation is prioritized, in contrast to traditional learning methods (Cai et al., 2019; Long et al., 2016). Many universities have instructional designers to assist instructors in transforming their traditional courses into online, hybrid, or blended learning courses. For this reason, the provision of the needs of the learning environment, technological infrastructure,

and course material by means of institutional support will contribute to achieving more effective learning performance in the flipped classroom method. However, at universities without instructional designers, instructors may be provided with limited support and they may have to rely on themselves. This can be challenging and overwhelming for instructors who do not have such experience. Therefore, improving instructors' competencies in integrating technology into their lessons are also important in making the flipped classroom method more efficient (Brun & Hinostroza, 2014). In this way, instructors will be able to make better use of such innovative approaches.

In the observation made during the Polymer Science and Technology course, where the flipped classroom method was applied, the 4 themes obtained from the interview were learning environment, course material, classroom activities, and student motivation. The fact that the learning environment was not proper for in-class activities of the course curriculum negatively affected the implementation of the course. When the observation findings were assessed using the TPACK framework, the dimensions of pedagogical and content knowledge came into prominence. On the other hand, providing a learning environment in which students can actively participate in classroom activities has increased students' motivation. Similarly, it was stated in the literature that a learning environment in which students can actively participate in the flipped classroom method would increase students' motivation in comparison to traditional learning methods (Arif & Omar, 2019; Nouri, 2016).

In the observation made during the Polymer Science and Technology course, where the flipped classroom method was applied, the 4 themes obtained from the interview were "Learning environment", "Course material", "In-class activities", and "Motivation". The fact that the learning environment was not proper for in-class activities of the course curriculum negatively affected the implementation of the course. When the observation findings were assessed using the TPACK framework, the dimensions of pedagogical and content knowledge came into prominence. On the other hand, providing a learning environment in which students can actively participate in classroom activities has increased students' motivation. Similarly, it was stated in the literature that a learning environment in which students can actively participate in the flipped classroom method would increase students' motivation in comparison to traditional learning methods (Arif & Omar, 2019; Nouri, 2016).

6 Conclusion

In a qualitative case study, the opinions of the instructors working at a state university and having experience with the flipped classroom method were examined through semi-structured interviews and observation. The findings of the study were discussed within the framework of TPACK. TPACK constitutes the theoretical framework of this study, due to the technology dimension that comes into prominence, particularly in the out-of-class activities of the flipped classroom, and it helps us in understanding the thoughts of the instructors about the integration of technology into learning environments, and also because it will be effective in the sustainability of learning efforts in the flipped classroom (Koehler & Mishra, 2009).

The flipped classroom method may offer an innovative way for instructors in comparison to traditional learning methods. In addition, the development, acquisition, or utilization of course material is related to the competencies of the instructors in integrating TPACK-related technology into learning environments (Kirshstein et al., 2000; Koehler & Mishra, 2009). While integrating technology into learning environments today, a pedagogical perspective should also be considered (Urban et al., 2018; Yıldız, 2020). Within the scope of this study, which was carried out with a view to examining the flipped classroom method not only from the students' but also from the instructors' point of view, the researchers tried to reveal how the instructors perceive the flipped classroom method, the technologies they use, the effects on the students, the challenges they confront, and their opinions and suggestions on making this method more effective. Furthermore, the use of the qualitative research method has helped the researchers deeply understand the main factors in the flipped classroom method.

7 Recommendations

It is hoped that the results of this study will contribute to advancing the flipped classroom method. It is also hoped that it would encourage instructors to be more receptive in applying new technologies to their teaching–learning situations in educational practices. Considering the study results, the following suggestions were made for educational practices.

- Students with low self-regulation skills fail to fully participate in out-of-class activities and come to the lesson unprepared, thus affecting in-class activities negatively. Therefore, it is necessary to take some precautions that will enable students to follow out-of-class activities in order to get this situation under control.
- A proper learning environment, technological infrastructure, and good organization of the course materials in the flipped classroom method will contribute positively to students' attitudes, motivation, and academic success. Therefore, organizing these items properly will enhance the efficiency of the flipped class.
- Instructors can be provided with training on integrating technology into learning environments so that they can use technology more effectively in the flipped classroom method. Instructors can be encouraged to create their own TPACK profiles. They can develop by reflecting on their degree of technological, pedagogical, and content knowledge in this way.

The following suggestions were made for future research considering the study results.

- Considering the suggestions for educational practices, it is recommended to investigate what can be taken precautions that will enable students with low self-regulation skills to follow out-of-class activities in the flipped classroom.

- It is recommended to investigate how to organize a proper learning environment, technological infrastructure, and the course materials in the flipped classroom method.
- It is suggested that further studies need to be carried out in order for educators' individual TPACK profiles to be researched and classified if possible.
- Finally, it is recommended that further studies need to improve the level of acceptance from instructors as well as motivate them about flipped classroom method.

Abbreviations TPACK: Technological pedagogical and content knowledge; CK: Content knowledge; PK: Pedagogical knowledge; TK: Technology knowledge; PCK: Pedagogical content knowledge; TCK: Technological content knowledge; TPK: Technological pedagogical knowledge

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Declarations

Competing interests The authors declare that they have no competing interests.

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