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The Effect of Preparing Lesson Plans in Online Flipped Learning Model on Pre-Service Teachers' Self-Efficacy Levels of TPACK

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This study aims to investigate the effects of developing lesson plans in flipped learning model on pre-service chemistry teachers' self-efficacy beliefs in technological pedagogical content knowledge (TPACK) and to obtain their views on flipped learning. The study adopts a pre-test and post-test design with one group. Twenty-five pre-service chemistry teachers joined the classes in subjects such as teaching methods and techniques, materials development and curriculum development. Teaching was done using the flipped learning model. The students also prepared their own lesson plans using the flipped learning approach. Results show that the participants progress in TPACK in general and in the sub-factors of technological knowledge, pedagogical knowledge, technological content knowledge, pedagogical content knowledge, and technological pedagogical content knowledge. Results reveal no statistically significant difference in the content knowledge sub-factor of TPACK. Pre-service teachers have positive thoughts about flipped learning model.

Keywords: Online Flipped Learning Model, Pre-Service Teachers, Self-Efficacy, TPACK

Introduction

The need for distance education and hybrid education in our age of

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development in digital technologies- especially during the pandemic that we have faced- has led to substantial changes in technologies used in classrooms. Research shows that some of the teachers who work actively in the area have difficulty in integrating technology in their classes, in what teaching method and technique to use and in deciding on what teaching technology to use at what stage (Angeli & Valanides, 2009; Bang & Luft, 2013; Harris et al., 2009; Kushner Benson et al., 2015; Niess, 2005; So & Kim, 2009). Teachers who can meet today's needs by adapting into the information society and who can adapt into the digital world by making use of the possibilities of technology are required. Pre-service teachers, who are the prospective implementers of curricula, should also possess new skills and should be able to apply new teaching methods, techniques and approaches. In this context, the term "technological pedagogical content knowledge" (TPACK)- which is formed by blending technological knowledge, pedagogical knowledge and content knowledge- and self-efficacy in it is important.

The TPACK model was created by blending technological knowledge into pedagogical knowledge and content knowledge (Kula, 2015). The three types of knowledge can be explained as in the following:

- **Content Knowledge (CK):** CK is teachers' and pre-service teachers' knowledge of principles, rules, theories, etc. of their domain (Koehler & Mishra, 2009).
- **Pedagogical Knowledge (PK):** PK, which is referred to as the general knowledge of teaching profession, involves knowledge of and skills in planning, executing and evaluating the teaching process.
- **Technological Knowledge (TK):** It involves knowledge of using the technologies described as digital technologies and classified as up to date information and communication technologies in addition to standard technologies (Kabakçi Yurdakul & Odabaşi, 2013).

The types of knowledge which are composed of the interaction of the three types can be described as:

- **Pedagogical Content Knowledge (PCK):** PCK, the intersection point of pedagogical knowledge and content knowledge, involves teachers' and pre-service teachers' knowledge of and skills in teaching a domain effectively (Kabakçı Yurdakul & Odabaşı, 2013).
- **Technological Content Knowledge (TCK):** It is the knowledge of choosing, using and evaluating technology relevant to the subject. It also means having knowledge of the domain which changes in parallel to technological implementations in addition to knowledge of the domain to

be taught (Kabakçı Yurdakul & Odabaşı, 2013).

- **Technological Pedagogical Knowledge (TPK):** An understanding of how teaching and learning can change when particular technologies are used in particular ways. This includes knowing the pedagogical affordances and constraints of a range of technological tools as they relate to disciplinarily and developmentally appropriate pedagogical designs and strategies (Koehler & Mishra, 2009).

TPACK- which represents TPACK- TK, CK, PK- the main components- can be explained as:

- **Technological Pedagogical Content Knowledge (TPACK):** TPACK emphasises the communication between special pedagogical approaches which show what type of understanding teachers have in terms of the interactions between technologies, pedagogy, the content of the curricula so as to teach the content effectively (Kula, 2015).

TEACHERS' SELF-EFFICACY

Bandura (1977) defines the perception of self-efficacy as the individual's feeling of the situation she/he is in or the power to perform an activity that she/he wants to perform. Teacher self-efficacy "is viewed as self-referent judgments of capability to organize and execute actions required to successfully perform teaching tasks and positively impact student learning" (Perera et al., 2019). Teacher self-efficacy is an important indicator of whether a teacher is an effective teacher, whether she/he is satisfied with her/his profession and continues to work (Klassen & Tze, 2014, cited in Granziera & Perera, 2019).

TPACK is a framework that defines the information that teachers need to use technology effectively in creating educational activities. Self-efficacy, on the other hand, is a person's belief in their ability to be successful in a particular situation. There is a relationship between TPACK and self-efficacy because a teacher with a strong sense of self-efficacy believes more in his or her ability to use technology effectively in teaching, which can increase their TPACK. On the other hand, a teacher without self-efficacy may be less likely to use technology in their teaching, which may hinder the development of their TPACK.

Teachers' self-efficacy is a factor which influences their success in their profession and their goals (Çakıroğlu et al., 2005). Their self-efficacy beliefs in TPACK plays significant roles in their integration of technology into their classes. Their tendency to use technology in their classes increases when they think that they are competent in integrating technology into the classroom environment (Abbit, 2011; Atman Uslu & Usluel, 2019; Cheng et al., 2020;

Ertmer and Ottenbreit-Leftwich, 2010; Karaca et al., 2013; Ottenbreit-Leftwich et al., 2010; Şahin et al., 2009; Wang et al., 2004).

Significance of TPACK and TPACK Self-Efficacy in Preparing Technology-Based Lesson Plans

Teachers need to integrate technology into their teaching processes appropriately in order to make flipped classrooms effective (Kushairi & Ahmi, 2021; Saab & Stengs, 2014). It has become inevitable today to develop lesson plans and teaching designs on the basis of technology. However, teachers have difficulties in application when they are taught the knowledge of technology independently in areas apart from their branch (Cengiz, 2013 cited in Canbazoğlu Bilici & Baran, 2015). Therefore, teaching designs in which the interactions between teaching methods and domains are emphasised should be employed (Harris & Hofer, 2011; Higgins & Spitulnik, 2008).

For example, it is not adequate for a teacher who wants to use inquiry-based teaching strategy in a chemistry class to have only content knowledge about the lesson (for instance, acids, bases, salts), only knowledge of teaching methods within the scope of pedagogical knowledge (for instance, research-inquiry based teaching strategy) or only technological knowledge (for instance, simulations). He or she should understand how to support research-inquiry based learning process and have knowledge about when and how to integrate technology into the teaching process by considering students' prior knowledge about acids, bases and salts, the concepts that they may have difficulty with and the probable misconceptions.

Flipped Learning Model

Flipped learning model is one of the teaching- learning approaches in which technology is intensely used in learning environments. The concept emerged first when Bergmann and Sams (2012) recorded their classes for students who missed the classes and sent them online so that they would not fall behind the class. In this way, such students could build basic knowledge before classes with the help of the lesson videos. In the model, the classical lesson routine in which students attended classes and did their homework individually at home was reversed (Yestrebsky, 2015). The purpose in doing so is to ensure that students take on active roles in the classroom by giving them the class materials in the form of homework (Smith, 2013). Abeysekera and Dawson (2015, p. 3) describes the general features of the model- which is referred to as “flipped classroom”, “inverter learning” as “flip learning” in the literature- as in the following:

- a change in use of classroom time
- a change in use of out-of-class time
- doing activities traditionally considered 'homework' in class
- doing activities traditionally considered as in-class work out of class
- in-class activities that emphasise active learning, peer learning, problem-solving
- pre-class activities
- post-class activities and
- use of technology, especially video

The model was described as "flipped classrooms" when it first emerged; but later it was mentioned as "flipped learning" due to the fact that it focussed on learning (Hayirsever & Orhan, 2018, p. 576). Therefore, it was called "flipped learning model" in this study.

Kırmızıoğlu (2018), conducted a study with 11th graders which lasted five months in total, concluded that flipped learning model was effective in promoting students' academic achievement in chemistry. The researcher also found that students had positive views on the model. In a similar way, Schultz et al (2014), in a study in which high school students were included, found that experimental group students who were taught in flipped learning model had significant increase in achievement in the chemistry course. On the other hand, there are also studies which demonstrated that flipped leaning model had positive effects on the increase in university students' academic achievement in chemistry classes. Göğebakan-Yıldız et al. (2016) and Bokosmaty et al. (2019) concluded that the flipped learning model they employed in General Chemistry classes increased students' academic achievement.

The above-mentioned studies showed that the model had positive effects on the chemistry achievement of students of different age groups. These are the results which indicate that technological pedagogical content knowledge is important for prospective teachers to be able to raise students who can adapt into the digital world.

FLIPPED LEARNING AND TPACK

In a flipped learning model, students are often responsible for reviewing content and completing activities outside of the classroom, while classroom time is used for more interactive, hands-on activities such as problem solving, discussion, and application of concepts. In this context, TPACK is particularly important for teachers as students must be able to use technology effectively to create and deliver engaging online content and activities that they can access and complete on their own.

A teacher with a high level of self-efficacy may be more confident in their ability to use technology in situations such as creating and implementing effective online content and activities for their students. Thus, the flipped learning model can be applied more successfully. Flipped learning model can improve teachers' and pre-service teachers' TPACK levels because it requires integrating technological instruments into classes in lesson plans. Jin and Harp (2020) conducted a study with the participation of pre-service teachers and found that the Educational Technology classes which they taught in team-based manner and in the form of traditional flipped learning caused increase in participants' levels of knowledge in TPACK and in the sub-factors of TPACK.

Several studies in the literature analysed the effectiveness of flipped learning model by means of lesson notes, test scores and lesson evaluation. Yet, no studies were found on how pre-service teachers could design their classes in flipped learning model. Therefore, this current study is expected to contribute to the literature in that it enables pre-service-teachers to develop their technological pedagogical content knowledge by putting their knowledge of different types together and that it enables them to experience flipped learning through applications done with them and through the lesson plans they themselves prepare.

REVIEW OF LITERATURE

The purpose of learning technology through design at TPACK is to create technology rich designs and to experience the design process (Chai et al., 2011). The flipped learning model is one of the approaches that allows technology to be adapted to learning environments. In the literature, there are various studies examining the TPACK levels of both teacher candidates and teachers within the framework of flipped learning.

Hall (2018) examined the effect of an inverted approach on the development of pre-service teachers' technological pedagogical content knowledge. In the study conducted with a single group pre-test and post-test design during an educational technology course, participants' self-perceptions about TPACK and their course designs were analysed. The findings revealed that the participants had a statistically significant increase in their self-perceptions about pedagogical knowledge (PC) and TPACK practice.

Widyasari et al. (2022) in their mixed method study, tested the effect of subject-specific pedagogy (SSP) through flipped learning on the TPACKs of chemistry teacher candidates. The result of this study showed that chemistry teacher candidates' skills from pre-test to post-test (stacking method) improved after the intervention was given. At the same time, it was revealed that the intervention given throughout the process effectively affected the TPACK of chemistry teacher candidates in terms of both personal ability and item difficulty level.

Wu et al. (2022), on Video-based flipped learning (VFL), a new form of flipped learning, investigated the TPACK levels, pedagogical beliefs of 211 junior high school and senior high school teachers, and the role of teachers' pedagogical beliefs on their TPACKs for VFL. The results of the study showed that the pedagogical beliefs of the secondary school teachers in this study were generally adequately expressed in their TPACK for VFL. They also showed significantly greater confidence in secondary school teachers' technological pedagogical content knowledge (TPACK) for the VFL compared to high school teachers.

Çetin-Dindar et al. (2018) found in a study with the participation of 17 pre-service chemistry teachers who attended the Instructional Technologies and Material Design Course that technology-based activities done throughout the semester were influential in the development of participants' TPACK levels. The study also concluded that more technological applications should be included in learning environments for self-efficacy in TPACK to develop more.

Jin and Harp (2020), in a study conducted based on flipped learning model with the participation of teachers of various branches, also reached similar conclusions. Harris and Hoffer (2011), who investigated the effects of secondary school teachers' TPACK levels on their lesson plans, found that lesson plans became more student-centred when teachers used instructional technologies more often in their classes and that they used teaching activities more consciously and more strategically as a result. Piotrowski and Witte (2016) examined English Language Arts teachers' TPACK development during an English education course focused on technology. During the flipped classroom applications, preservice teachers taking an online education course, learned how to design lessons integrating technology. The course enhanced preservice teachers' content knowledge, pedagogical knowledge, and technological knowledge to create flipped lessons videos and a series of lesson plans.

The above-mentioned studies found that working with technological instruments developed pre-service teachers' self-efficacy in TPACK and enabled them to see how they could develop their TPACK self-efficacy.

Smith and Dobson (2011) and Pasternak (2007) found that pre-service teachers would use technologies in their classes in the future if they learned and experienced them during their undergraduate education.

The research problem was formulated so as to answer the questions, "to what extent do the curriculum development practices made with pre-service teachers on the basis of flipped learning and their own work of flipped learning lesson plan have effects on their self-efficacy beliefs in technological content knowledge?" and as "what are their thoughts on their experience with flipped learning model?"

AIMS OF THE STUDY

This study aims to identify the effects of lesson plan development activities done with pre-service chemistry teachers in flipped learning model and their work of designing their own lesson plans in flipped learning approach on their self-efficacy beliefs in technological pedagogical content knowledge and also to identify their views on flipped learning. This study analyses how pre-service teachers learn the flipped learning approach while investigating whether it is effective or not. Besides, it also aims to provide them with experience in how to integrate technology in their classes. The participants used their content knowledge, pedagogical knowledge and technological knowledge in developing lesson plans according to flipped learning, in preparing activities for classes and in preparing videos by integrating the knowledge into the course gains.

RESEARCH METHODOLOGY

The research was prepared in one-group pre-test and post-test model. The independent variable is given to a randomly chosen group in one-group pre-test and post-test model. Both pre-experimental (pre-test) and post-experimental (post-test) measurements are made. If post-test measurement results are bigger than the pre-test measurement results, the result is regarded as stemming from applications and evaluation is made accordingly at the end of a study (Karasar, 2012).

DATA COLLECTION TOOLS

Technological Pedagogical Content Knowledge Scale

The Technological Pedagogical Content Knowledge Scale- which was developed by Horzum et al. (2014) was used in identifying the participants' self-efficacy beliefs in their technological pedagogical content knowledge. The scale which was first designed as having 122 items consistently with the sevencomponent model of technological pedagogical content knowledge, was given its final shape and it contained 51 items by considering experts' opinion and students' opinion after the first application. The content validation and face validation of the scale was done by 12 experts of the area. The criterion validity of the scale was attained by comparing it with the scale prepared by Öztürk and Horzum (2011), of which validity and reliability was proven previously. The correlation coefficient between the two scales was found as 0.52 ($p<0.05$) and the correlation was found statistically significant. Construct validity was tested through confirmatory factor analysis. After the confirmatory factor analysis, six items were included in the factor of technological knowledge, seven items in the factor of pedagogical knowledge, eight items in the factor of content knowledge, six items in the factor of technological content knowledge, eight items in the factor of pedagogical content knowledge, eight items in the factor of technological pedagogical knowledge and eight items were in the factor of technological pedagogical content knowledge. The construct validity of the seven-factor, 51-item scale was attained in this study. Horzum et al. (2014) used the test-retest method as well as the internal consistency test method for reliability test. The correlation coefficients of the seven factors took on values between 0.91 and 0.95 as a result of the test-retest. The Cronbach Alpha coefficients of the seven factors took on values between 0.84 and 0.89 at the end of the internal consistency test. The scale results were found to be reliable at the end of both methods.

Semi-Structured Interviews

The five participants who were chosen from each group on the basis of volunteering were given semi-structured interviews about flipped learning model and about their experiences in preparing lesson plans and activities according to the model at the end of the study.

In order to prepare the interview questions, first of all, a literature review was made. After the literature review, an item pool consisting of ten questions related to the subject was created. In order to ensure content validity, the questions in the item pool were examined by two faculty members who were experts in the field and their opinions were also taken. After the examination, some questions were arranged, and five questions were decided to be asked to the students during the interviews.

The questions asked to the pre-service teachers in the interviews were:

1. What do you think about the flipped learning model?

2. What are the positive and negative aspects of this model according to you?

3. In which type of subject or course do you think the flipped learning model would be more appropriate?

4. While preparing the lesson plan in the flipped learning model, did you have difficulty integrating technological tools into your lesson?

5. Do you plan to implement this model when you start teaching? Can you explain your reason?

Interviews were conducted face-to-face with each pre-service teacher. Each interview lasted an average of 30 minutes. Researchers for the consistency that ensures internal reliability, asked questions to each participant with the same approach throughout the semi-structured interviews. The audio was recorded, then the recordings were listened to and transcribed. For confirmability that ensures external reliability, the findings are reported in a clear and understandable way.

SAMPLE FOR THE STUDY

The study group was composed of 25 volunteering pre-service chemistry teachers who had taken the Curriculum Development and Instruction, Teaching Principles and Methods, Instructional Technology and Material Development courses and passed the exams. The pre-service teachers who have taken those courses are knowledgeable about teaching principles and methods and are competent in preparing materials consistent with course content.

Stages of Implementation

- The study started by informing the participants of flipped learning model in a presentation in a Zoom session.
- Then, the participants were given on digital platform the Technological Pedagogical Content Knowledge scale developed by Horzum et al (2014) as the pre-test.
- After informing the pre-service teachers, they were asked to subscribe to the classroom opened on White Panel Teaching Platform (White Panel platform is a virtual classroom application which is open to all the educators and students for free and in which educators can share educational materials with students and can create environments for discussion).
- The interventions in the study were made and the presentation videos and

discussion environment prepared by the teacher were used consistently with the flipped learning model. In this way, the pre-service teachers had the opportunity to experience flipped learning practice as students. The videos reminding teaching methods and techniques, material development and curriculum development were uploaded to the virtual classroom every week and thus, the participants were made to remember the basic concepts.

- The participants were divided into groups on the Zoom platform for the implementation process in the classrooms.
- Each group designed lesson plans in which flipped learning model was integrated suitably to grade levels they chose. They designed such stages as determining course gains, teaching methods and techniques, technological materials and measurement and evaluation approaches. They also determined the implementations of flipped learning model for pre-class, during class and after class.
- The groups had Zoom meetings with the researchers every week. The group members identified at what stage they were in their task and exchanged views in the meetings. They could contact the teacher whenever they wanted and asked for help in the process. The teacher could also guide the participants in this process through regular meetings and intervene in the problems that could arise. The pre-service teachers' experience with the process and their thoughts on the model were revealed through interviews with them in Zoom meetings at the end of the study.

The Pre-Service Teachers' Process of Preparing Lesson Plans According to Flipped Learning Model

The 25 participants were divided into 5 groups randomly. The students in group one (4 female students and 1 male student) prepared unit plans about the topic namely, Liquid Solutions and Solubility and Factors Which Influence Solubility. The students in this group based their lesson plans on 5E learning model. The 5E learning model is a teaching process based on the constructivist approach. It was developed by Roger Bybee and consists of Engage, Explore, Explain, Elaborate and Evaluate stages (Bybee, 1997). The activities planned to be done before the lesson followed the stages of “attracting attention”, “discovering” and “explaining”. A digital story was created for use in attracting attention. The activities to be done during the class followed the stages of “explaining” and “deepening”. The applications of “Edpuzzle” and “Kahoot” and concept cartoons were used at this stage. The final stage consisted of evaluation. The students chose the application

"Google Jam board" for use in evaluation. They prepared a multiple-choice test in this application. Group wise bifurcation is given in Table 1.

The students in group two (5 girls) prepared lesson plans on the topic Mixtures and Separating the Mixtures. Two gains were available for the subject. These students also prepared their unit plans according to 5E Learning Model. Technological materials included in their unit plans were experiment videos which were planned to send before the lesson. 3 experiments were designed to be done during the lesson.

The students in group three (4 girls and 1 boy) chose the topic of Gases. Only one gain was available for the subject. The students prepared a poster and an oral presentation to be sent before the lesson. They also prepared a mini test in the application "Padlet" to check the prior knowledge. The participants made use of simulation applications called "Phet" in presenting the subject. They finished their design of lesson plans by preparing a test with the application "Socrative" for evaluation purposes.

The students in group four (3 boys and 2 girls) chose the topic Liquid Solutions and Solubility and the Factors Which Influenced Solubility. They prepared an oral presentation and a quiz with the application "Quizlet" to be sent before the lesson. The quiz was used as introduction to the activities to be done during the lesson. The application Kahoot was used so as to check whether or not the presentation sent prior to the lesson was watched. An experiment suitable to the subject was planned after the quiz. A research question was prepared to make evaluation at the end of the class.

The students in group five (5 girls) prepared lesson plans about the ninth-grade topic "States of Matter". They prepared lesson presentation videos to be sent before the lesson and they also prepared a detailed presentation in addition to the videos. They used "Edpuzzle" to check whether or not the videos were watched. However, they did not use technological materials during the lesson. Instead, they prepared four questions- with which they aimed to create an environment of discussion in the classroom. For evaluation after the lesson, they assigned homework by using "Online Test Maker".

Table 1

The Subjects and Activities in the Pre-Service Teachers' Lesson Plans Prepared According to Flipped Learning Model.

Group Number	The Unit/Grade Level Chosen	Activities Planned and the Programmes Used for the Pre-Class	Activities Planned and the Programmes Used for While-Class	Activities Planned and the Programmes Used for After Class
Group I	Liquid Solutions and Solubility and Factors which Influence Solubility 11th grade	A digital story	A digital play application with Edpuzzle and Kahoot, concept cartoons	Evaluating the application with a multiple-choice test Google Jumboard
Group II	Mixtures and Separating the Mixtures 10th grade	Experiment videos	3 experiments	Worksheets related to the experiments
Group III	Gases 11th grade	A poster and oral presentation, A mini test with Padlet	Phet Simulation application	Evaluation with a test (Socrative)
Group IV	Gases 11th grade	Oral presentation and a quiz with Quizlet	Evaluating the pre-class presentation, an experiment with Kahoot	A research question
Group V	Liquid Solutions and Solubility and Factors which Influence Solubility 11th grade	Video of subject presentation (whether or not it was watched was checked with Eddpuzzle)	Discussion method	Evaluation (Online Test Maker)

The Technological Pedagogical Content Knowledge scale developed by Horzum et al (2014) was given to the participants as the pot-test at the end of the implementations.

FINDINGS OF THE STUDY

The statistical analyses were done, and averages and standard deviations were calculated by using the SPSS package programme so as to identify the TK, CK, PK, PCK, TPK and the TPACK levels. Descriptive statistics were used in the analysis of quantitative data.

Table 2

Results of the Participants' Answers to the Sub-Factors of the Technological Pedagogical Content Knowledge Scale.

	Pre-test		Post-test	
Components	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
TK	22.50	4.032	24.87	3.60
PK	25.96	4.42	29.54	3.50
CK	32.58	3.60	34.67	3.78
TCK	22.25	3.89	25.37	4.17
PCK	30.92	4.46	34.58	4.06
TPK	31.21	4.54	34.46	4.02
TPCK	30.58	5.01	33.92	4.35
Total	196.00	26.74	217.42	25.55

The maximum scores receivable for the sub-factors of the Technological Pedagogical Content Knowledge Scale were as follows: 30 for technological knowledge, 35 for pedagogical knowledge, 40 for content knowledge, 30 for technological content knowledge, 40 for pedagogical content knowledge, 40 for technological pedagogical knowledge and 40 for technological pedagogical content knowledge.

According to data in Table 2, on examining the pre-test and post-test scores received from the sub-factors of the scale, it was found that the scores received from all the sub-factors were above the average (Figure 1).

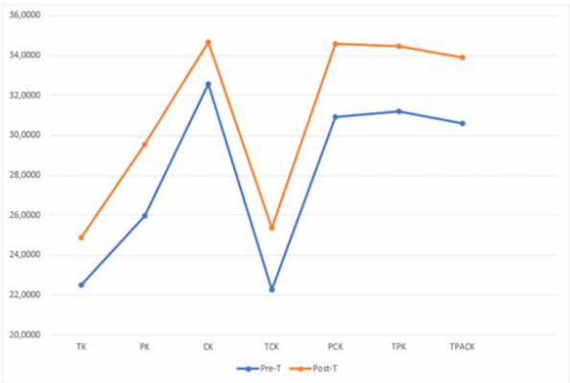

Figure 1: The Average Scores for the Sub-factors of the TPACK Scale Before and After the Implementation

Wilcoxon signed rank test was used to find whether or not there were any statistically significant differences between the pre-service chemistry teachers' self-efficacy beliefs in their technological pedagogical content knowledge in lesson plan development application through flipped learning model and in their work of designing lesson plans in flipped learning model prior to and after the implementation.

Wilcoxon signed rank test is one of the non-parametric statistical methods used to eliminate the validation of the distribution of the data problem in cases where the number of samples is less than 30 (Baştürk, 2011). In this study, Wilcoxon signed rank test was used in order to eliminate the disadvantages that may arise from the sample size of 25.

Accordingly, significant differences were found in scores received from the pre-test and post-test in the sub-factors of technological knowledge ($Z=1.91$, $p<0.05$), pedagogical knowledge ($Z=2.63$, $p<0.05$), technological content knowledge ($Z=-2.16$, $p<0.05$), pedagogical content knowledge ($Z=-3.58$, $p<0.05$), technological pedagogical content knowledge (-2.18, $p<0.05$) and in the scale ($Z=-2.52$, $p<0.05$). No significant differences were found in the sub-factor of content knowledge in the pre-test and post-test.

Analysis of Qualitative Data

The participants were given semi-structured interviews for both the flipped learning model and their experiences with preparing lesson plans and activities according to the model.

During the interviews with the pre-service teachers, audio recordings were taken and then the recordings were listened to and transcribed. During the analysis of the data, pre-service teachers were coded as ÖA1, ÖA2… in accordance with ethical rules.

The participants were first asked to state their views on flipped learning model as students during the interviews. They generally stated positive views. The participant coded as ÖA2, for instance, stated that he/she liked the model and that he/she found especially the presentation videos sent prior to the lesson very useful in the sentence "the videos sent before the lesson were the parts that I liked the most because I could reach the presentation whenever I wanted. It caused me to have self-confidence while preparing for the examination." Another participant considered sending theoretical knowledge through videos as something negative and said that he/she had difficulty in distinguishing the key points of the subject since the teacher was not available in the environment while learning the basic knowledge.

ÖA5, another participant who stated positive views, said that he/she was much more active in classes which were taught in flipped learning model than in classes taught in traditional methods. Apart from that, the negative views stated were generally about failure to take on equal duties in group work done during classes.

The participants' views stated in relation to their experience with designing lesson plans according to flipped learning model were also positive in general. They said that they first learned the flipped learning model within the scope of this course and also stated that they were happy for learning it. They also found it challenging at the beginning. All the participants thought that students were active in the model. Therefore, they said that they tried to include activities in which students could join actively in the unit plans they prepared. For example, participant ÖA5- who was in group three and who said what he/she liked the most about the model was ensuring students' active participation- included in their unit plans which they prepared with their partners in their group simulations through which they thought they gave students the opportunity to be more active in classes. In the same way, the participants who thought that the presentation videos sent before the classes were very useful also designed a digital story for use before the lesson. They said that presentation of the subject would be retained more easily in mind in this way.

When the pre-service teachers were asked whether they had difficulty integrating technological tools into their lessons while preparing a lesson plan in the flipped learning model, most of them stated that they did not have any problems using technological tools, but at first, they were worried about whether they could use them correctly in their lesson plans, but these concerns disappeared in the process. For example, ÖA1 in the first group stated that as a group, they benefited from digital stories in their lesson plans, they learned the digital story creation process very easily at the beginning of the study, they had difficulties in deciding which stage to use in the lesson, but over time they overcame it.

It was found at the end of the interviews that the pre-service teachers tended to prepare unit plans on the basis of their experiences with the flipped learning model. The participants, who thought that making students active was the best property of the model, used more heavily the activities in which students could take on active roles in their lesson plans. Besides, they also said that their previous experiences were influential at the stage of choosing a subject to design a unit plan. They said that they tried to choose the chemistry subjects which they could divide into stages of pre-class, during-class and after-class while designing their unit plans.

All of them said that their research skills increased while designing activities suitable to the model. They were also found to use web 2.0 tools which they had not used before while designing activities and materials suitable to the model and thus, their teaching skills also developed.

CONCLUSIONS AND DISCUSSION

This study found that the participants had received scores above the average in all sub-factors of the TPACK scale; and thus, they were at a good level in this respect. Besides, the preservice teachers included in the study were also found to make progress in the TPACK as well as in TPACK sub-factors of technological knowledge ($Z=-1.91$, $p<0.05$), pedagogical knowledge ($Z=-2.63$, $p<0.05$), technological content knowledge ($Z=-2.16$, $p<0.05$), pedagogical content knowledge ($Z=-2.66$, $p<0.05$), technological content knowledge ($Z=-3.58$, $p<0.05$) and technological pedagogical content knowledge ($Z=-2.18$, $p<0.05$). However, no statistically significant differences were found between the pre-test and post-test in the sub-factor of content knowledge.

The participants had experience of designing hybrid lesson presentation due to the nature of the model. During the study, pre-service teachers had the chance to participate in flipped learning applications as students, and they also had the chance to design flipped learning applications with their own lesson plans. During the applications, they prepared digital stories, interactive lesson and experiment videos, kahoot quizzes, concept cartoons, and benefited from Phet animations. They had the experience of applying digital technologies and integrating them into the learning outcomes of the course. The need for integrating instructional technologies into classes on digital teaching platforms and during face-to-face teaching enabled all the sub-factors of technological pedagogical content knowledge to develop in this model. The reason for not finding statistically significant differences in the sub-factor of content knowledge was the fact that more time would be needed for the development of content knowledge or that material preparation and intention to use it actively in classes might have been prioritised.

Hofer and Grandgenett (2012), in a similar way, analysed pre-service teachers' TPACK development in a three-year pre-service teacher development programme. The participants were asked to use technology in their lesson plans and lesson presentation in instructional technologies and teaching methods classes throughout the implementation. At the end, the pre-service teachers were found to make progress in TPACK and in the sub-factors of it but that they had limited development in the TCK sub-factor. Guzey and Roehrig (2009), in a study conducted with the inclusion of secondary school teachers, found that the teachers' levels of TPACK had improved as a result of the c-maps, computer simulations and video applications- which were done to demonstrate how to use technology in their classes.

Ceylan et al. (2014) found that using information communication technology in classes led to a rise in pre-service teachers' TPACK levels. Mouza et al. (2014), on the other hand, secured increase in pre-service teachers' levels of TPACK by getting them prepare lesson plans by using instructional technologies in teaching methods classes and by putting them into action in their teaching.

It was found through the semi-structured interviews with the pre-service teachers that they in general had positive views on the learning model considered here. In their qualitative study, Yıldız et.al (2022), examined the teaching experiences of instructors in flipped classrooms in the TPACK framework. They determined that TPACK-related competencies were very important in integrating technology into their courses and preparing materials for flipped classrooms. Zhang and Fang (2022) in their study, 12 university teachers of English as a foreign language investigated their knowledge and teacher competency regarding the flipped classroom (FC) application. When the interview data were examined, it was seen that there were opinions that the flipped model had a positive effect on teacher efficacy. However, there are also teachers who think that the reasons such as technology not being user-friendly and impersonal features have negative effects on self-efficacy. The pre-service teachers who participated in our study did not mention negative effects such as technology that is not user-friendly. The reason for this difference in opinion may be that pre-service teachers who are digital natives are more interested in technology than in-service teachers.

RECOMMENDATIONS

It is extremely important for pre-service teachers to get acquainted with technological possibilities during their undergraduate education which they can use in their classes in the future and to be able to integrate them into their classes in our era- when technology has become an integral part of education. Activities to raise pre-service teachers' levels of TPACK should be designed during their education. Considering the fact that hybrid learning environments may also be used after pandemic, pre-service teachers should be introduced to such learning environments, and they should be taught to prepare lessons in hybrid learning environments. There should be more activities that will enable pre-service teachers to understand the flipped learning model, increase the acceptance level of education to be applied with flipped learning, and motivate teacher candidates. Further studies may be conducted by using flipped learning model with larger samples to improve their TPACK levels. Individual differences which influence pre-service teachers' achievement and their TPACK levels and other factors may be investigated in such studies.

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