Education and Information Technologies (2024) 29:7321–7340
https://doi.org/10.1007/s10639-023-12134-4

Exploring the relationship between pre-service teachers' TPACK and blended teaching readiness levels: a path analysis

Mücahit Öztürk[1] · **Pınar Mıhcı Türker**[1] · **Gökhan Kerse**[2]

Received: 14 August 2022 / Accepted: 10 August 2023 / Published online: 14 August 2023
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Abstract

This study explored pre-service teachers' technological pedagogical content knowledge levels and their blended teaching readiness. In this context, the study employed the cross-sectional survey design, and the variables were analyzed descriptively and correlationally. The study was carried out with the participation of 477 pre-service teachers. Data were collected using the Blended Teaching Readiness Instrument and the Technological Pedagogical Content Knowledge-Deep (TPACK deep) Scale. The analyses put forth that pre-service teachers technological pedagogical content knowledge levels were high in the dimensions of design, exertion, and proficiency, whereas their levels were moderate in the dimension of ethics. In addition, pre-service teachers' blended teaching readiness levels were found to be high in the dimensions of dispositions, online integration, data practices, personalizing instruction, and online interaction. Furthermore, a significant and positive high-level correlation was revealed between pre-service teachers' technological pedagogical content knowledge levels and their blended teaching readiness. Also, pre-service teachers' technological pedagogical content knowledge levels could explain 66% of the variance in their blended teaching readiness.

Keywords Blended teaching · Pre-service teachers · Technological pedagogical content knowledge · Blended teaching readiness

✉ Mücahit Öztürk
mucahitozturk@aksaray.edu.tr

[1] Department of Computer Education and Instructional Technology, Aksaray University, Aksaray, Turkey

[2] Department of Management Information Systems, Kafkas University, Kars, Turkey

1 Introduction

The integration of information and communication technologies into the teaching process has led to the development of different pedagogies. In addition to face-to-face teaching, teachers have started to use different pedagogies such as online teaching and blended teaching. Blended teaching has become increasingly widespread with its feature combining the advantages of face-to-face teaching and online teaching (Calderón et al., 2021). In this period, as we approach the end of the COVID-19 pandemic, higher education institutions have started to actively use blended teaching (Pardede, 2019). The flexible structure of blended teaching has made it widely used in teacher education programs (Martín-Martínez et al., 2020). Teacher training programs should prepare students to use online technologies and methods appropriate for blended teaching (Tondeur et al., 2020). On the other hand, there is not enough data on teachers' and students' readiness levels for blended teaching (Adams et al., 2021). Only a limited number of studies examined pre-service teachers' blended teaching readiness (Archibald et al., 2021; Arnesen et al., 2019; Sugiharto et al., 2019). The reasons such as the fact that blended teaching has a complex structure and requires the ability to use different technologies and methods together revealed the importance of training pre-service teachers well (Jenkins & Crawford, 2021). The technological pedagogical content knowledge (TPACK) framework can offer the necessary information and application areas for teachers or pre-service teachers to integrate technology into the teaching process along with pedagogy and content knowledge (Mishra & Koehler, 2006). Since pre-service teachers are expected to know what to teach in the future and how to teach the course content integrated with technology, it is necessary for pre-service teachers to go beyond pedagogy and content knowledge and integrate technology into the teaching process (Papanikolaou et al., 2017). For this reason, it has become the priority of teacher training institutions to provide pre-service teachers with the necessary knowledge and skills to use technology appropriately in the teaching process (Tondeur et al., 2020). These competencies expected from pre-service teachers encourage researchers to determine TPACK levels and develop them (Aktaş & Özmen, 2020; Santos & Castro, 2021). Examining pre-service teachers' TPACK levels can guide the preparation of the necessary infrastructure for them to use technology effectively and efficiently in the teaching process (Redmond & Lock, 2019). As blended teaching has become widespread, it has been emphasized that teacher training programs should provide skills related to the TPACK areas (Neumann et al., 2021). In their study examining the studies on blended teaching, Short et al. (2021) revealed that there is a need to determine teachers' and pre-service teachers' competencies and preparation levels regarding the blended teaching process. Assessing the blended teaching readiness of future teachers within the framework of TPACK can provide significant contributions, as the blended teaching process involves the integration of online technologies with learning environments. Some studies have suggested that the blended teaching process can positively contribute to the development of pre-service teachers' TPACK skills (Kılıç et al., 2019; Sintawati & Abdurrahman, 2019). The relationship between blended learning and TPACK skills has been demonstrated in various studies. However, there is a need to identify the factors that can influence teachers' readiness for blended learning, which is considered important for

designing more effective learning environments. Unlike previous studies, this study argued that pre-service teachers' TPACK levels can increase their blended teaching readiness. In this context, the extent to which the TPACK levels of pre-service teachers predict their readiness for blended learning has been examined.

2 Literature review

2.1 Blended teaching

Blended teaching is a field of study that researchers are interested in with its technology-supported different teaching modes and its potential to enrich the learning environment. Blended teaching is not a new concept and there has been debate over its definition for a long time. Oliver and Trigwell (2005) examined the different definitions of blended teaching in their study and defined it as the combination of online technologies with traditional learning and the use of different pedagogies at the same time. Easy access to online technologies has revealed the potential of blended teaching to become the new normal from elementary education to higher education (Pardede, 2019). While students have the opportunity to learn independently in online sessions, they can communicate in real-time and work collaboratively in face-to-face sessions (Jenkins & Crawford, 2021). The fact that blended teaching reduces the limitations of online teaching in terms of interaction and allows more effective use of time in the face-to-face teaching process encourages researchers to work in this field.

Previous studies have shown that blended teaching positively affects students' participation and academic achievement (Mestan, 2019; Şentürk, 2021) and that the experiences of teachers and students involved in the blended teaching process are positive (Cunningham, 2021). With the positive effects of blended teaching being seen, it has become widespread in all education levels. However, in this process, teachers need to design activities in line with face-to-face lessons, develop online content, and use asynchronous and synchronous technologies (Calderón et al., 2021). This made it important for pre-service teachers who will design and conduct the teaching process in the future to be prepared to use online technologies (Ates Cobanoglu & Cobanoglu, 2021). Although there are studies assessing teachers' and students' blended teaching readiness (Hauk et al., 2021; Saboowala & Mishra, 2021), there is also a need for studies assessing pre-service teachers' blended teaching readiness. Adams et al. (2021) found that the blended learning readiness of 274 undergraduate students was at a sufficient level, and they demonstrated differences based on gender, ethnicity, and field of study among the students. The researchers suggested that larger sample studies involving different research groups should be conducted, and emphasized the evaluation of blended teaching readiness in relation to pedagogical factors that may impact course designs. Hamzah et al. (2021) assessed 137 undergraduate students' blended learning readiness and reported that students had low readiness. They suggested that more studies should be conducted to increase students' blended learning proficiency. Junus et al. (2021) explored instructors' readiness for online teaching during the pandemic and found that while instructors were technically competent, they had limitations in developing strategic solutions to problems that may

arise in the online environment. Ates Cobanoglu and Cobanoglu (2021) examined pre-service teachers' readiness for online learning and revealed high readiness levels, although readiness levels varied across different departments. Since blended teaching is a process in which online technologies are actively used, the TPACK framework can guide teachers to carry out the blended teaching process effectively (Qasem & Viswanathappa, 2016).

2.2 The TPACK framework

The TPACK framework can provide an effective structure for pre-service teachers to use technology in the teaching process in an integrated manner with existing pedagogy and content knowledge (Al-Abdullatif, 2019). Mishra and Koehler (2006) developed the TPACK framework on seven basic knowledge areas:

Technology knowledge: It is the knowledge area regarding the use of educational technologies.

Pedagogical knowledge: It is the knowledge area regarding learning and teaching methods.

Content knowledge: It is the knowledge area regarding the subject to be learned or taught.

Technological content knowledge: It is the knowledge area regarding designing course content using appropriate technologies.

Technological pedagogical knowledge: It is the knowledge area regarding which methods can be used more effectively in the teaching process.

Pedagogical content knowledge: It is the knowledge area regarding which methods can present certain topics more effectively.

Technological pedagogical and content knowledge: It is the knowledge area regarding how to teach the course content using appropriate technologies and methods.

Yurdakul et al. (2012) identified six indicators within the scope of TPACK competencies and indicators, utilizing the TPACK framework created by Mishra and Koehler (2006). These indicators include designing instruction, implementing instruction, innovativeness, ethical awareness, problem-solving, and field specialization. Designing instruction involves analyzing the current situation prior to the teaching process. The teachers should determine the methods, techniques, and technologies to be used. Additionally, they should be able to develop materials, environments, activities, and assessment tools, as well as plan instructional conditions.

The implementing of instructions involves the practical execution of teaching strategies. Teachers should consider indicators such as using technology to motivate students, evaluating the effectiveness of the teaching process, and employing technology-based assessment methods for student success. As part of fostering innovation, teachers should utilize technology to update their knowledge and skills related to the content they teach. Staying informed about the content, technology, and teaching process, as well as leveraging new online environments to support teaching and learning, are indicators encompassed within innovation.

The competence of ethical awareness includes qualifications such as paying attention to access rights in technology use, digital intellectual property issues in technology-based contexts, and paying attention to ethical rules of the teaching profession.

The indicators of this competence involve the teacher guiding students to behave ethically while accessing technological resources, behaving ethically in accessing digital sources used when designing materials, directing students to reliable internet sources, paying attention to personal security and privacy issues, and behaving ethically in technology-based teaching processes to evaluate students' achievements.

The problem-solving competency involves resolving issues related to technology, the teaching process, and content knowledge. Teachers should be able to solve basic problems related to the technological tools used in the teaching process, utilize technology to address problems that may arise during learning and teaching, and employ technology to provide solutions to challenges encountered in structuring content. Field specialization entails being an expert in the subject area. Teachers should be capable of guiding their colleagues on the use of technology to address problems that may arise in the presentation of content.

TPACK knowledge areas can be effective in designing a technology-supported teaching process by pre-service teachers (Santos & Castro, 2021). TPACK levels of pre-service teachers were reported to differ according to research groups. There are studies showing pre-service teachers' TPACK levels low (Al-Abdullatif, 2019), medium (Kartal & Afacan, 2017), and high (Tan et al., 2019; Santos & Castro, 2021). Researchers examined the relationships between pre-service teachers' TPACK levels and use of digital technologies (Schmid et al., 2021), different cultures and disciplines, sex (Naaz & Khan, 2018; Redmond & Peled, 2019), 21st century skills (Valtonen et al., 2017), skills to use Web 2.0 tools (Wright & Akgunduz, 2018), and TPACK competencies (Kara, 2021). There is a need to develop TPACK levels and conduct more studies in order to increase the quality of pre-service teachers and train them better (Al-Abdullatif, 2019). There are limited number of studies examining blended teaching that includes the technology integration process in the context of TPACK. Kılıç et al. (2019) examined the effect of the blended learning environment designed based on TPACK on the development of pre-service teachers' TPACK levels and classroom practices. Blended teaching had a positive impact on pre-service teachers' TPACK development and their ability to develop practices in the classroom. It was suggested that TPACK skills may be an important factor for blended teaching and that more studies should be conducted to reveal the relationship between the components of blended teaching and TPACK.

Sintawati and Abdurrahman (2020) examined the effect of blended learning environment on the development of pre-service teachers' TPACK levels in multimedia-assisted mathematics teaching. Accordingly, blended teaching significantly improved pre-service teachers' TPACK levels in multimedia-assisted mathematics teaching. Kurniasih et al. (2022) measured the willingness of elementary school teachers to implement blended learning. According to the results, the TPACK skills of the teachers were found to be very good, and therefore, it was concluded that the teachers could implement the blended learning process. The researchers stated that by measuring the TPACK skills of the teachers, their readiness for the blended learning process could be improved and the quality of education could be increased, but they also noted that the existing studies are still not clear. Yatun et al. (2021) stated that the teaching process has changed and become online due to the pandemic. In this context, they emphasize the need for teachers to have technology teaching skills. Additionally,

the researchers noted that it is important to examine the TPACK knowledge used by teachers in the blended learning process. Albeta et al. (2023) also emphasize the importance of teachers having knowledge in the technological and pedagogical area because this knowledge is important when implementing blended learning. Mulyadi et al. (2020) emphasized the importance of examining the TPACK levels of teachers to achieve the best practice in the blended learning process. Similarly, Mujallid (2021) emphasized the importance of TPACK level for teachers to effectively deliver online courses and stated that there is a need for studies in this regard.

In conclusion, previous studies found the positive effect of blended teaching practices on pre-service teachers' academic performance, participation, and TPACK levels (Pardede, 2019; Sintawati & Abdurrahman, 2020; Şentürk, 2021). Therefore, it is important for pre-service teachers to experience blended teaching during their undergraduate education. However, as the teachers of the future, pre-service teachers should be ready to be able to design and carry out blended teaching. The few researchers who examined pre-service teachers' blended teaching readiness suggested more data collection. The fact that blended teaching is a process that includes the active use and integration of information and communication technologies requires pre-service teachers to be able to design technology-enriched teaching (Nguyen, 2022). This made TPACK competencies even more important for pre-service teachers while designing technology-supported teaching processes (Demirtaş & Mumcu, 2021). The results of the studies examining pre-service teachers' TPACK levels are complex, thus data should be collected from different samples. The present study examined pre-service teachers' TPACK levels and blended instruction readiness. Although the importance of pre-service teachers' TPACK levels in the blended teaching process was emphasized in different studies (Kılıç et al., 2019), there is a need for research on the effect of TPACK levels on the blended teaching process. In this context, this study explored the effect of pre-service teachers' TPACK levels on their blended teaching readiness and presented a structure for future research and instructional designers regarding the effect of the TPACK framework on the blended teaching process.

2.3 Purpose of the study

The present study explored pre-service teachers' blended teaching readiness and their TPACK levels. It also examined to what extent pre-service teachers' TPACK levels predicted their blended teaching readiness. The study sub-problems are as follows:

1. What are the pre-service teachers' TPACK levels?
2. What are the pre-service teachers' blended teaching readiness levels?
3. At what level do pre-service teachers' TPACK predict their blended teaching readiness?

3 Method

The study utilized a cross-sectional survey design to assess the TPACK levels and blended teaching readiness of pre-service teachers (Büyüköztürk et al., 2015). Descriptive and correlational analyses were conducted to examine the participants' blended teaching readiness and their TPACK levels. The purpose of this design was to gather data at a specific point in time and analyze the relationship between the variables of interest. The descriptive analysis aimed to provide an overview of the participants' readiness for blended teaching and their TPACK levels. The correlational analysis aimed to explore any associations or relationships between these variables. This design allowed for the collection of data from a large sample of pre-service teachers and provided insights into the current state of their blended teaching readiness and TPACK levels.

3.1 Participants

The study was carried out with the participation of 477 pre-service teachers studying at the Faculty of Education of a university in Turkey in the spring semester of the 2021–2022 academic year. Participants were majoring in Guidance and Psychological Counseling, Music Education, Art Education, Mathematics Education, Science and Technology Education, Preschool Education, Elementary Education, Social Studies Education, and Turkish Language Education at the Faculty of Education. The participants were 4th year students and had taken the same education courses, had a similar cultural structure, and were living in Turkey. For the selection of the participants, the convenience sampling method was used so that the researchers would easily collect data. Also, 73.4% of the participants were female and 25.4% of them were male. The participants' mean age was 21.87 ($SD = 2.3$). Pre-service teachers had participated in online and blended teaching processes during the pandemic and had an average of two years of experience.

3.2 Data analysis

Analyses for the study were made with the SPSS and AMOS package programs. Using these programs, normality test analysis, descriptive analyses, confirmatory factor analyses, reliability analyses, Pearson's correlation analysis, and path analysis were performed. The reason for using path analysis in the study is that it covers two or more regression equations and describes complex regression problems in a simple way. In addition, this method helps to separate the relationships between path analysis variables into causal and non-causal components (Lleras, 2005).

3.3 Data collection tools

The Technological Pedagogical Content Knowledge-Deep Scale and the Blended Teaching Readiness Instrument were used to collect data for this study. Pre-service teachers filled out the scales using the traditional method (on paper) on a voluntary basis. The researchers administered the scales to the participants in the classroom

before or after the lessons after taking the necessary permission. Demographic information was asked from the participants regarding their major, age, sex, and experience of taking online courses.

3.3.1 Technological pedagogical content knowledge scale (TPACK-deep)

The TPACK-deep scale was developed by Yurdakul et al. (2012) to measure pre-service teachers' TPACK competencies. The scale includes items assessing pre-service teachers' levels of technological, pedagogical, and content knowledge in the learning and teaching process. The 33-item scale consists of four dimensions, namely design, exertion, ethics, and proficiency. The *Design* dimension of the TPACK-deep scale includes the competencies of pre-service teachers regarding the enrichment of the teaching process by using their technology and pedagogy knowledge, the analysis of the current situation before the lesson, and the design of the lesson with the appropriate methods, techniques, and technologies. The *Exertion* dimension includes the competencies of pre-service teachers regarding the execution of the process and the assessment of its effectiveness. The *Ethics* dimension includes the ethics competencies of pre-service teachers regarding technology, in other words, their competencies regarding their knowledge of the principles and ethical responsibilities regarding access right. Finally, the *Proficiency* dimension includes the competencies of pre-service teachers regarding their ability to guide their colleagues in the use of technology while trying to solve the problems faced when presenting the content.

There are various measurement tools in the literature aiming to define TPACK competencies. However, the TPACK-deep scale emphasizes TPACK sub-components. It contains a deep structure with four factors: design, exertion, ethics, and proficiency. Also, the TPACK-deep scale is used to examine pre-service teachers' technology integration competencies (Kabakcı Yurdakul, 2018). For this reason, in the present study, it was deemed appropriate to collect data using this scale.

3.4 Blended teaching readiness instrument (BTRI)

Developed by Archibald et al. (2021), BTRI was adapted into Turkish by Mıhcı Türker and Öztürk (2022). The scale was developed to determine pre-service teachers' blended teaching readiness levels and their strengths and weaknesses. The adapted version of the scale has 33 items and consists of five dimensions, namely dispositions, online integration, data practices, personalizing instruction, and online interaction. The *Dispositions* dimension of the BTRI focuses on pre-service teachers' attitudes and beliefs regarding blended teaching. The *Online Integration* dimension includes items about the ability to make and implement decisions about when and how to effectively combine online and face-to-face learning. The *Data Practices* dimension includes items about pre-service teachers' ability to use digital skills to monitor student activity and performance, and to make informed choices about interventions that will help all students progress. The *Personalizing Instruction* dimension focuses on pre-service teachers' ability to implement a learning environment that allows students to customize goals, pace, or learning path. Finally, the *Online Inter-*

action includes items about pre-service teachers' ability to facilitate online interactions both with students and among students.

3.5 Findings

3.5.1 Normality test findings

In the study, before the basic analyses, whether the assumption of normal distribution for the data was met was examined. In this direction, the skewness and kurtosis values of TPACK-deep and BTRI were examined. Since these values for both scales (see Table 1) were between −2 and +2 (George & Mallery, 2016), it was determined that the assumption of normal distribution was met. Thus, other analyses in the study were performed with reference to this finding.

3.6 Reliability and validity findings

In the study, factor analyses and reliability analyses were conducted on the scales. In the exploratory factor analysis, the explained variance value of the TPACK-deep scale was determined as 59.08%. In the reliability analysis, the Cronbach's alpha coefficient of this scale was found to be 0.950. The internal consistency alpha coefficients for the dimensions ranged from 0.850 to 0.920. Since these values were greater than 0.70 (Hair et al., 2017), scale reliability was ensured. Also, the confirmatory factor analysis determined that item factor loadings varied between 0.500 and 0.832 (Table 2). These values were found to be higher than the reference 0.40 (Hair et al., 2017).

Finally, "CMIN, DF, CMIN/DF, SRMR, CFI, RMSEA" values were examined for model fit (Table 3). The following are referenced for these indexes: $0 < X2/df < 5$ for CMIN/DF; <0.08 for SRMR; >0.90 for CFI; and <0.08 for RMSEA (Gürbüz, 2019). The fit index values of the TPACK-deep scale are presented in the Table 3. All fit index values provided reference values.

In the explanatory factor and reliability analyzes performed on the BTRI scale, the explained variance value of the scale was determined as 61.05% and the Cronbach's alpha coefficient as 0.931. The internal consistency alpha coefficients for the dimen-

Table 1 Skewness and Kurtosis Values of the Scales

Variables	Skewness	Kurtosis
TPACK-deep proficiency	-0.562	0.291
Design	-1.106	2.775
Exertion	-1.023	1,679
Ethics	-0.612	0.331
Proficiency	-1.011	1.563
BTRI	-0.943	1.579
Dispositions	-0.492	0.441
Online Integration	-0.754	0.763
Data Practices	-0.743	0.625
Personalizing Instruction	-0.540	0.432
Online Interaction	-0.872	0.726

Table 2 Factor Loadings of TPACK-deep Scales

Variable	Factor Loading
TPACK-deep	
Dispositions1	0.500*
Dispositions2	0.625*
Dispositions3	0.589*
Dispositions4	0.622*
Dispositions5	0.588*
Online Integration1	0.628*
Online Integration2	0.706*
Online Integration3	0.648*
Online Integration4	0.778*
Online Integration5	0.755*
Data Practices1	0.650*
Data Practices2	0.804*
Data Practices3	0.775*
Data Practices4	0.778*
Data Practices5	0.701*
Personalizing Instruction1	0.600*
Personalizing Instruction2	0.719*
Personalizing Instruction3	0.727*
Personalizing Instruction4	0.730*
Personalizing Instruction5	0.736*
Personalizing Instruction6	0.766*
Personalizing Instruction7	0.786*
Personalizing Instruction8	0.733*
Online Interaction1	0.613*
Online Interaction2	0.671*
Online Interaction3	0.779*
Online Interaction4	0.832*
Online Interaction5	0.819*

*$p<.05$

Table 3 Model Fit Values of TPACK-deep Scale

Indexes	Reference Value	TPACK-deep
CMIN	-	761.304
DF	-	337
CMIN/DF	$0<\chi 2/df<5$	2.296
SRMR	<0.08	0.040

sions ranged from 0.730 to 0.895. Therefore, it was determined that the scale was reliable. In addition, as seen in Table 4, factor loadings were over 0.40 (between 0.546 and 0.734). Additionally, all factor loadings were statistically significant ($p<.05$).

The fit index values of the BTRI scale are given in Table 5. When these values are examined, it is seen that the fit index values meet the references.

Table 4 Factor Loadings of BTRI Scales

Variable	Factor Loading
BTRI	
Design1	0.643*
Design2	0.667*
Design3	0.669*
Design4	0.701*
Design5	0.662*
Design6	0.698*
Design7	0.665*
Design8	0.549*
Design9	0.572*
Design10	0.639*
Exertion1	0.672*
Exertion2	0.605*
Exertion3	0.683*
Exertion4	0.670*
Exertion5	0.613*
Exertion6	0.656*
Exertion7	0.675*
Exertion8	0.603*
Exertion9	0.713*
Exertion10	0.691*
Exertion11	0.603*
Exertion12	0.661*
Ethics1	0.732*
Ethics2	0.630*
Ethics3	0.734*
Ethics4	0.660*
Ethics5	0.651*
Ethics6	0.646*
Proficiency1	0.546*
Proficiency2	0.682*
Proficiency3	0.715*
Proficiency4	0.657*
Proficiency5	0.703*

*$p < .05$

Table 5 Model Fit Values of BTRI Scale

Indexes	Reference Value	BTRI
CMIN	-	1116.041
DF	-	486
CMIN/DF	$0 < \chi 2/df < 5$	2.259
SRMR	< 0.08	0.043
CFI	> 0.90	0.916
RMSEA	< 0.08	0.051

Table 6 Descriptive analyses of pre-service teachers' technological pedagogical content knowledge competency levels

Dimension	Item number	*N*	Lowest	Highest	*M*	*SD*
Design	10	477	1.00	5.00	4.05	0.60
Exertion	12	477	1.33	5.00	4.06	0.61
Ethics	6	477	1.33	5.00	3.91	0.67
Proficiency	5	477	1.40	5.00	4.19	0.63
TPACK Level	33	477	1.41	5.00	4.05	0.57

Table 7 Descriptive analyses of pre-service teachers' blended teaching readiness levels

Dimension	Item number	*N*	Lowest	Highest	*M*	*SD*
Dispositions	5	477	1.00	6.00	4.39	0.87
Online Integration	5	477	1.00	6.00	4.69	0.86
Data Practices	5	477	1.20	6.00	4.67	0.87
Personalizing Instruction	8	477	1.00	6.00	4.50	0.88
Online Interaction	5	477	1.40	6.00	4.96	0.85
Blended Teaching Readiness	33	477	2.16	5.88	4.64	0.67

3.7 Pre-service teachers' TPACK levels

The TPACK-deep scale was used to determine pre-service teachers' TPACK levels. Descriptive analyses of 477 pre-service teachers are presented in Table 6.

According to Table 6, pre-service teachers got 1.41 the lowest from the TPACK-deep scale, and 5.00 the highest. The pre-service teachers' mean score on the scale was 4.05. Therefore, pre-service teachers' TPACK levels were found high based on the scoring determined by Yurdakul et al. (2012). When pre-service teachers' scores were examined by considering all the scale dimensions, their scores were high on the design, exertion, and proficiency dimensions, and moderate on the ethics dimension.

3.8 Pre-service Teachers' blended Teaching readiness levels

BTRI was used to determine pre-service teachers' blended teaching readiness levels. Descriptive analyses of 477 pre-service teachers are presented in Table 7.

According to Table 7, pre-service teachers got 2.16 the lowest from the BTRI, and 5.88 the highest. The pre-service teachers' mean score on the scale was 4.64. The average score of the pre-service teachers was found to be 4.64. Based on the scoring levels obtained for the upper 27% and lower 27% (Yurdakul et al., 2012), pre-service teachers' blended teaching readiness levels were high. When pre-service teachers' scores were examined by considering all the scale dimensions, the participants' mean scores on all dimensions were high.

3.9 The relationship and effect between pre-service teachers' TPACK levels and their blended teaching readiness

The relationship between pre-service teachers' TPACK levels and their mean scores on blended teaching readiness is presented in Table 8.

Table 8 Pre-service Teachers' TPACK Levels and Blended Teaching Readiness: Results of Pearson Product-Moment Correlation Analysis

TPACK-deep	BTRI	*N*	*r*	*p*
Design	Dispositions	477	0.336	0.000
	Online Integration	477	0.510	0.000
	Data Practices	477	0.558	0.000
	Personalizing Instruction	477	0.617	0.000
	Online Interaction	477	0.602	0.000
	Blended Teaching Readiness	477	0.681	0.000
Exertion	Dispositions	477	0.329	0.000
	Online Integration	477	0.502	0.000
	Data Practices	477	0.599	0.000
	Personalizing Instruction	477	0.620	0.000
	Online Interaction	477	0.586	0.000
	Blended Teaching Readiness	477	0.685	0.000
Ethics	Dispositions	477	0.256	0.000
	Online Integration	477	0.461	0.000
	Data Practices	477	0.533	0.000
	Personalizing Instruction	477	0.596	0.000
	Online Interaction	477	0.485	0.000
	Blended Teaching Readiness	477	0.605	0.000
Proficiency	Dispositions	477	0.334	0.000
	Online Integration	477	0.492	0.000
	Data Practices	477	0.528	0.000
	Personalizing Instruction	477	0.504	0.000
	Online Interaction	477	0.535	0.000
	Blended Teaching Readiness	477	0.621	0.000
TPACK Level	Dispositions	477	0.345	0.000
	Online Integration	477	0.542	0.000
	Data Practices	477	0.612	0.000
	Personalizing Instruction	477	0.645	0.000
	Online Interaction	477	0.608	0.000
	Blended Teaching Readiness	477	0.715	0.000

According to Table 8 that presents the results of the Pearson product-moment correlation analysis, the relationship between the mean scores of the dimensions in both scales and the overall mean scores of the scales was significant. A significant positive and high correlation was determined between the mean score of pre-service teachers' TPACK levels and the mean score of blended teaching readiness ($r = .715$; $p < .05$). In other words, there is a significant and positive high correlation between pre-service teachers' TPACK levels and their blended teaching readiness.

When the scores for pre-service teachers were examined on the basis of the dimensions in the scale, the lowest positive relationship was between the mean scores of ethics and dispositions ($r = .256$; $p < .05$), whereas the highest moderate positive correlation was between the mean scores of exertion and personalizing instruction ($r = .620$; $p < .05$). Based on these findings, there was a significant and positive but low-level relationship between pre-service teachers' ethical competence towards technology and their attitudes and beliefs towards blended teaching. Also, there was a significant and moderate relationship between the ability to execute the process and evaluate the effectiveness and the skills for customizing learning environments.

Table 9 Research Model Fit Values

Indexes	Reference Value	Research Model
CMIN	-	3463.641
DF	-	1753
CMIN/DF	$0<\chi 2/df<5$	1.976
SRMR	<0.08	0.048
CFI	>0.90	0.902
RMSEA	<0.08	0.046

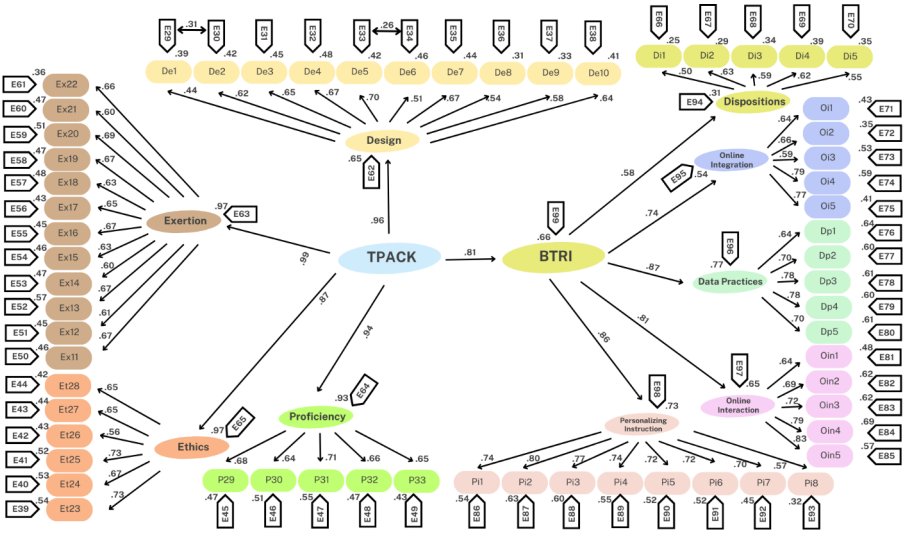


Fig. 1 Structural model for the relationship between TPACK and blended teaching readiness

Table 10 The Findings on Effect

Predictor	Predictive	Standardized Regression Weights	*S.E.*	*C.R.*	*p*	R^2
TPACK Level	Blended Teaching Readiness	0.812	0.088	6.833	0.000	0.660

In the study, after determining the relationship between the TPACK levels and blended teaching readiness, path analysis was performed to determine the effect. Before the path analysis, a model showing the relationship between the two scales was created and the fit indices were examined. As can be seen in Table 9, the findings regarding the model fit indicate that the reference values are provided. In the study, TPACK was considered as exogenous variable and Blended Teaching Readiness (BTRI) as internal variable and path analysis was performed. The resulting structural model is given in Fig. 1. The prediction results, on the other hand, are presented in Table 10.

The table findings show that pre-service teachers' TPACK levels affected their blended teaching readiness levels positively and significantly (0.812; $p<.05$). In

addition, pre-service teachers' TPACK levels could explain 66% of the variance in their readiness for blended education.

4 Discussion

Blended teaching, the new normal for the post-pandemic period, is now a process requiring all teachers to be ready technologically and pedagogically (Pulham & Graham, 2018). The present study examined pre-service teachers' TPACK levels and their blended teaching readiness at a descriptive and correlational level. Pre-service teachers' blended teaching readiness was found high on all dimensions. In other words, pre-service teachers had high-level attitudes and beliefs towards blended teaching and high-level competencies in the effective application of the process, making informed choices about interventions that will help students progress, and increasing interactions. This may be due to the fact that staff members and pre-service teachers had participated in online classes and increased their experience during the pandemic. In addition, conducting the courses online may have given the instructors the opinion that online teaching is important and may have contributed to the training of pre-service teachers in this direction. Jenkins and Crawford (2021) emphasized the importance of teacher trainers in educating their students in a way that requires them to understand and be ready for blended teaching. Karatas and Arpaci (2021) put forth that improving pre-service teachers' 21st century skills may increase their readiness for online learning. In the university where the study was conducted, pre-service teachers were taking different courses such as Instructional Technologies, face-to-face education and distance education, and multimedia design. The courses taken by the pre-service teachers on the pedagogies and technologies of face-to-face and online teaching processes may have positively affected their blended teaching readiness.

In the present study, pre-service teachers' TPACK levels were similarly high. Pre-service teachers' levels of the TPACK design, exertion, and proficiency dimensions were also high, whereas their levels of the ethics dimension were moderate. Accordingly, it can be said that pre-service teachers are competent in enriching the teaching process by using their technology and pedagogy knowledge, analyzing the current situation before the lessons, and guiding their colleagues in the use of technology to solve the problems experienced during the lessons. In the study conducted by Kabakçı Yurdakul (2018), pre-service teachers' TPACK levels were found to be high in all dimensions and the highest average score was obtained in the ethical dimension. These findings were similar to the results of the present study. However, the ethical dimension was moderate in the present study. Santos and Castro (2021) also found pre-service teachers' TPACK levels high in all dimensions. Thus, except for the ethical dimension, parallel results were revealed. Based on the results of the present study, the learning objectives of pre-service teachers on ethical competencies for technology should be enriched (Kabakci Yurdakul, 2018; Santos & Castro, 2021). However, it is believed that this situation may result from the fact that the importance of the concept of digital ethics was not attained by the pre-service teachers sufficiently.

There is a high level of positive correlation between pre-service teachers' TPACK competencies and their blended teaching readiness. Accordingly, it is expected that pre-service teachers with a high TPACK level will also have a high blended teaching readiness. Considering the level of impact, pre-service teachers' TPACK competencies largely predict their blended teaching readiness. Wright and Akgunduz (2018) revealed a positive relationship between pre-service teachers' TPACK self-efficacy levels and their use of Web 2.0 tools. Researchers stated that web 2.0 applications positively affect TPACK self-efficacy beliefs. Considering that blended teaching requires technological competencies, it is believed that the result of the study is in parallel with the results in the present study, and blended teaching readiness requires some technological and pedagogical competencies. Furthermore, positive relationships were found in the scale's sub-dimensions. However, the relationship between ethical competencies towards technology and attitudes and beliefs towards blended teaching was low. This may be due to the fact that the attitude towards blended teaching and ethical values towards technology could not be sufficiently associated with the contents.

5 Conclusion

There are many studies examining in-service teachers' blended teaching readiness and TPACK levels. Unlike previous studies, the present study assessed pre-service teachers' blended teaching readiness in relation to their TPACK levels. Today, face-to-face teaching gives way to blended teaching, and the education and training processes are shaped by face-to-face and online sessions. The results of the study presented data that may be important for literature. Based on this, a need for pre-service teachers to actively use blended teaching in their classrooms emerged. Accordingly, pre-service teachers' blended teaching readiness for and high TPACK levels became important. It is vital to organize teacher training programs in such a way to develop TPACK levels, which significantly predict their blended teaching readiness. In this direction, an infrastructure can be developed for pre-service teachers to actively and effectively use blended teaching in their own classrooms in their professional lives.

5.1 Future research

There is a need for research that will explore pre-service teachers' blended teaching readiness, which is believed to become one of the common pedagogies of the future. In the study, the participants' blended teaching readiness and TPACK levels were high in all dimensions. However, it was found to be moderate in the ethical dimension. The reasons why the ethical dimension was revealed to be moderate can be examined both quantitatively and qualitatively in different studies. Which additional content will be needed in order to make the learning objectives regarding the ethical dimension sufficient and how the learning environments will be enriched according to these objectives can be explored. In addition, reexamining the relationship between blended teaching readiness and TPACK with different professional groups, such as teachers can determine whether the level of the relationship is also similar

to the present study. By focusing on low-correlated ethical and tendency factors, it can be examined why the level of correlation between these two variables is low or whether similar findings can be obtained with different groups. Participants in the study continue their education processes by taking regular online courses. In different studies, data can be collected from universities that do not have sufficient online infrastructure and from pre-service teachers with different online course experiences, and the results can be evaluated. In addition, since the data were obtained using the simple sampling method, comparisons can be made using different sampling methods. Researchers can study with research groups in different countries and at educational levels and examine variables that may affect blended teaching readiness.

Data Availability The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Data Availability The data used is available on request.

Declarations

Conflict of interest The authors has no relevant financial or non-financial interests to disclose.

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