Psychometric Properties of the Turkish Version of the AI-TPACK Scale

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Abstract

Artificial Intelligence (AI) has led to many paradigms shifts in the world of education. One of the variables determining the integration of AI tools into education is teachers' AI-TPACK competencies. This study aimed to adapt the AI-TPACK Scale to Turkish. The study sample consisted of 316 teachers. The AI-TPACK Scale and the AI Attitude Scale were used as data collection tools in the study. According to the results of the reliability analyses conducted on the AI-TPACK Scale, Cronbach's alpha and McDonald's omega values were found to be .88. Confirmatory Factor Analysis (CFA) results proved that the fit indices of the AI-TPACK Scale were at an acceptable level. The scale's item factor loadings, item discrimination indices, and convergent validity findings were at acceptable levels. Significant positive relationships were observed between the AI Attitude and AI-TPACK used for criterion validity. Therefore, all the results of the study confirm that the AI-TPACK Scale is a reliable and valid measurement tool that can be used in studies in Turkish culture.

Keywords: Artificial Intelligence, AI-TPACK, AI Attitude

Introduction

Artificial intelligence (AI) is defined as the field of study that aims to systematically implement behaviors unique to humans, such as thinking, reasoning, problem solving, and learning, through computer systems (Gil de Zúñiga et al., 2024). In other words, it can be defined as the imitation of human behaviors through computer systems (Yang et al., 2025). In this sense, it is possible to use AI in many fields by imitating human behavior. One of the important areas where AI is adopted and used is education and training. Considering the place of technology in contemporary education, AI is becoming an important component by offering new tools every day in learning and teaching processes. By providing adaptable, data-driven systems, it can contribute to the individualization of learning and teaching processes by evaluating student profiles (Adeleye et al., 2024; Ouyang et al., 2023).

Thanks to the personalized learning process offered by AI, it can assist teachers in their roles by analyzing students' individual needs, providing responses to them, and providing individual-centered guidance (Deng, 2024; Nazaretsky et al., 2022). AI helps find effective solutions in designing materials

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that can be used in teaching activities and developing innovative teaching methods thanks to the information it obtains as a result of its interaction with humans (Ouyang et al., 2023). Furthermore, AI can make significant contributions to making learning processes more efficient from a pedagogical perspective. Despite these advantages, issues such as data privacy and access to personal information in learning environments, the risk of not providing equal opportunities in access to technology, and the possibility of undermining human-centered values can pose significant ethical and practical challenges (Akgün & Greenhow, 2022; Harry, 2023). Teachers' technological and pedagogical skills (TPACK) play a critical role in making these advantageous and disadvantageous situations that may be encountered during the integration of AI into education functional in terms of educational environments (Göçen & Aydemir, 2020).

In addition to teachers' TPACK skills, "Artificial Intelligence-Enhanced Technological Pedagogical Content Knowledge" (AI-TPACK) is a factor that facilitates or hinders the integration process. AI-TPACK can be defined as expanding the traditional TPACK framework of teacher professional knowledge to include AI-specific competencies (Goldman et al., 2024). In other words, while TPACK is the synthesis of content knowledge, domain knowledge, and technology knowledge (Yang et. al., 2025), AI-TPACK is the integration of artificial intelligence into this process (Lan, 2024). Within the TPACK framework, competencies in the areas of Technological Knowledge (TK), Technological Pedagogical Knowledge (TPK), and Technological Content Knowledge (TCK) are examined (Karatas & Aksu-Atac, 2025). In AI-TPACK, AI-based tools are integrated into the TK, TCK, TPK, and TPACK components (Setiyawan et al., 2025). It is characterized as the competence of teachers to be aware of not only their content, pedagogical, and technological competencies, but also the potential of AI-enabled hardware, as well as their responsibilities and ethical responsibilities on the teacher's part (Fanaturiza & Rindaningsih, 2024; Ning, 2024).

AI-TPACK focuses not only on teachers' proficiency in using artificial intelligence tools but also on their suitability for objectives, pedagogical effectiveness, compliance with ethical guidelines, and holistic approach from a critical perspective (Aldemir et al., 2025; Çelik, 2023; Yang et al., 2025). In this context, AI-TPACK can enable teachers to interpret feedback from AI-supported systems, address it in the context of learning outcomes, and design learning environments considering students' cognitive, affective, and ethical development (Aldemir et al., 2025; Çelik, 2023). Research shows that increased AI-TPACK competencies positively impact teachers' professional development and classroom interactions (Çelik, 2023; Chiu et al., 2023). In addition to facilitating the process of integrating AI applications into teachers' lessons, AI-TPACK can also contribute to teachers' selection and use of effective teaching strategies (Goldman et al., 2024; Kim, 2024; Ning, 2024). Considering the importance of the integration process of AI-TPACK into teaching processes for teachers, there is a need for measurement tools that can evaluate teachers' AI-TPACK processes in the Turkish context.

When scales focused on AI or TPACK used in Turkey were examined, it was determined that AI attitude (Alan et al., 2024; Türk et al., 2025), AI anxiety (Akkaya et al., 2021), AI readiness for change (Çakan & Akın, 2024; Ramazanoglu & Akın, 2025), AI acceptance (Batuk et al., 2025a), AI mindset (Batuk et al., 2025b), and TPACK (Kabakci Yurdakul et al., 2012; Kaya et al., 2013) scales were developed and used. Studies generally included AI or TPACK scales aimed at teachers or prospective teachers. Therefore, it was determined that scales for evaluating AI-TPACK were limited (Çelik, 2023). In this

context, this research focuses on the adaptation of a scale that can evaluate the impact of AI on teaching processes within the framework of teacher competencies.

The AI-TPACK Scale (Hojeij et al., 2024) adapted for this study examines the functionality of generative AI in an instructional context and its concrete impact on teacher practices, rather than general AI attitudes, unlike traditional AI or TPACK scales in Turkey. The scale's smaller number of items compared to other AI scales is particularly important for saving time and energy. Indeed, long scale items can hinder the process of collecting quality data, as they can increase participant inattention and fatigue. In this context, the 12-item AI-TPACK Scale is expected to facilitate studies addressing teachers' AI-TPACK competencies and related variables.

Method

This scale adaptation research was designed using the survey model, a quantitative research method (Karasar, 2012). This section includes demographic information about the study's participant group and evidence of validity and reliability for the AI-TPACK Scale used as the data collection tool.

Participants

The sample of the study consists of 316 teachers working at different school levels in the 2025-2026 academic year. The sample size was determined using the G*Power program [alpha level (0.05), high power (0.95), effect size medium level (0.3)], and it was concluded that 316 participants were sufficient. Since the data was collected via Google Forms, there were no missing data or duplicate responses, and data analysis was performed on 316 participants. When selecting participants for the research, convenience sampling, a non-probability sampling technique, has been used to determine the sample group. Most of the participants were teachers working in public schools in the eastern region of Turkey. Table 1 presents the sociodemographic characteristics of the participants:

Table 1

Sociodemographic Characteristics of Participants

Variables	*Categories*	*N*	*%*
Gender	Male	160	50.6
	Female	156	49.4
Age	25 and under	36	11.4
	26-30	78	24.6
	31-35	68	21.5
	36-40	45	14.2
	41 and over	89	28.3

School Level	Kindergarten	47	14.9
	Primary School	53	16.6
	Middle School	54	17.1
	High School	162	51.4
Field	STEM	69	21.8
	Humanities	59	18.6
	Basic Education	125	39.6
	Sports and Arts	19	6.1
	Guidance and Counseling – Special Education	44	13.9
Total		316	100

According to Table 1, 50.6% of the participants are male and 49.4% are female. 11.4% of the participants are 25 and under, 24.6% are 26-30, 21.5% are 31-35, 14.2% are 45, and 28.3% are 41 and over. 14.9% of the participants work in kindergarten, 16.6% in primary school, 17.1% in middle school, and 51.4% in high school. 21.8% of the participants teach in STEM, 18.6% in Humanities, 39.6% in Basic Education, 6% in Sports and Artistic, and 13.9% in Guidance and Counseling-Special Education.

Data Collection Tools

AI-TPACK Scale: Developed by Hojeij et al. (2024), the AI-TPACK Scale consists of a single dimension and 12 items. A 5-point Likert-type (1: Strongly Disagree to 5: Strongly Agree) rating is used in the scale to determine the raters' level of agreement. "Generative AI enhances the development of communication skills, such as writing and presentation skills" and "the success of Generative AI as a teaching tool is contingent upon adequate teacher training" are examples items in the scale. The reliability coefficient of the original scale was determined as Cronbach's Alpha $\alpha = 0.95$, demonstrating a high reliability value.

AI ATTITUDE: The AI Attitude scale developed by Grassini et al. (2023) is a 4-item and single factor scale adapted to Turkish by Türk et al. (2025) and uses a 10-point Likert scoring system. "I believe AI tools will make my life easier." and "I believe AI tools will improve my job/profession." are example items of the scale. The Turkish version of the scale's Cronbach's alpha coefficient was 0.89, and McDonald's Omega (ω) was 0.89. In addition, confirmatory factor analysis fit indexes are $\chi 2$ /df=2.52, RMSEA=0.06, CFI=0.99, TLI=0.99.

Language Validity

To adapt the scale to the Turkish sample and culture, the authors were first contacted via email and the necessary permissions were asked. Ethical approval was obtained from the Scientific Research and Publication Ethics Board of Siirt University for the study (Document Date and Number: 11.12.2024-8104). At the beginning of the adaptation process, the researchers examined the scale and its items. It was determined that the AI-TPACK Scale and its items were suitable for the targeted sample. The

translation steps of the scale were carried out using the method recommended by Brislin et al. (1973). The scale items were translated into Turkish by four field experts fluent in both Turkish and English. The translation was reviewed by two field experts for clarity of the questions and cultural appropriateness of the sentence structure. The translated scale was translated into English by two faculty members from the English department for grammatical analysis. It was observed that the translation procedures did not result in any loss of meaning. Two Turkish teachers reviewed the scale's suitability for Turkish. Necessary corrections were made based on feedback. The prepared scale was administered to 15 students studying in the Turkish Language Teaching Department. It was determined that there were no unclear items. In the final phase, the scale was administered to 316 teachers contacted via online platforms via Google Form.

Process

Informed consent was obtained from participants who voluntarily joined the study. Then, the responses of 316 teachers were examined to ensure the reliability of the data set. Since no issues such as incorrect coding, careless responses, or uniform scoring that threatened the reliability of the data set were encountered, analyses were conducted on 316 teachers. The study data were analyzed using SSPS 27 and AMOS programs. Statistical significance was determined at $p<0.05$. Validity analyses included first-level multifactor confirmatory factor analysis, convergent validity, item discrimination, and language and content validity. The AI Attitude scale was used to ensure the criterion validity of the research. This is because attitudes guide behavior and influence the intention that translates into behavior. Davis (1989) emphasizes that beliefs are important in the use of new technologies and that attitudes play a decisive role in their use. Furthermore, AI-TPACK is related to AI Attitudes (Xu et al., 2025). Cronbach's Alpha and McDonald's Omega reliability coefficients, and the composite reliability (CR) value method were used to determine the reliability of the scale. Model fit criteria, comparative fit indices, absolute fit values, and residual fit values were used for the CFA. For the internal validity of the scale, the item mean scores between the bottom 27% and the top 27% groups were tested using a t-test. Because the scale yields a total score, it was evaluated both overall and within each subscale. Additionally, Pearson correlation coefficients were calculated between the overall scale and its dimensions to test the construct validity of the scale.

Findings

In this section of the research, descriptive statistics, validity and reliability results of the adapted AI-TPACK Scale are included.

Table 2

Descriptive Statistics and Item Analysis Results of the AI-TPACK Scale Items

Items	*Mean*	*Sd*	*Skewness*	*Kurtosis*	*Item Total Correlations*	*Common Factor Variances*
Item 1	3.68	.75	-.47	.52	.54	.41
Item 2	3.69	.76	-.45	.19	.57	.43

Item 3	3.59	.73	-.42	.45	.44	.35
Item 4	3.87	.77	-.49	.31	.53	.63
Item 5	3.88	.73	-.67	1.20	.66	.67
Item 6	3.86	.62	-.90	2.85	.61	.57
Item 7	3.85	.69	-.88	1.63	.60	.53
Item 8	3.71	.73	-.90	1.53	.60	.48
Item 9	3.79	.67	-.93	2.06	.65	.59
Item 10	3.42	.90	-.79	.42	.41	.71
Item 11	3.74	.75	-1.02	2.05	.65	.54
Item 12	3.87	.68	-1.04	2.88	.61	.49

As seen in Table 2, the corrected item-total correlation values range from .41 to .66. These values should be above .30 (Büyüköztürk, 2018). The common variance values range from .35 to .71. This value should be above .20 (Büyüköztürk et al., 2014). The skewness and kurtosis values of the items range from -.42 to 2.88. According to Kline (2011), for the normality assumption to be met, the skewness and kurtosis values must be less than 3. Although items 6, 11, and 12 are within acceptable limits, the increasing use of artificial intelligence among teachers and the benefits it offers may have contributed to high kurtosis values.

Findings Regarding Validity Analysis

The 12-item, single-factor structure of the AI-TPACK Scale was tested utilizing CFA. The measurement values of the CFA results confirming the single-factor structure of the scale are shown in Figure 1. Modifications were made to obtain higher acceptable fit indices during DFA. These modifications involved inserting item pairs (e4–e5, e9–e10, and e11–e12) containing contextually similar statements. These items belong to the same conceptual domain and are applied within the same scale, thus theoretically justifying the associated residuals.

Factor loadings for the AI -TPACK Scale ranged from .48 to .72. The validity of the confirmatory factor analysis results was assessed using overall model fit (X^2 goodness-of-fit test, X^2 /sd), comparative fit indices (CFI, NFI, IFI, RMSEA), and absolute fit values (GFI, AGFI). In the interpretation of model fit values, the references cited by Tabachnick and Fidell (2007), Bayram (2013), and Karagöz (2017) were taken into consideration. Table 3 below shows the good and acceptable fit values obtained from the CFA result.

Table 3

Fit Values of the AI-TPACK Scales's Measurement Model

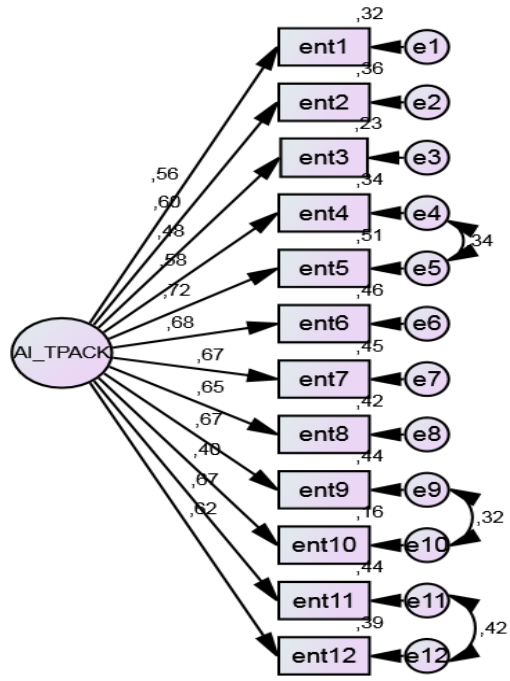
	X^2/df	*CFI*	*IFI*	*AGFI*	*GFI*	*RMSEA*	*NFI*	*TLI*
Good Fit	≤3	≥.95	≥.95	≥ .90	≥.90	≤.05	≥.95	≥.95
Acceptable Fit	3<X^2/sd<5	≥.90	≥.90	≥.85	≥.85	≤.08	≥.90	≥.90

AI-TPACK Fit Values	3.63	.91	.91	.87	.91	.08	.90	.90

Table 3 reveals that the X^2/df (3.63) value is below 5. The values for other fit indices are CFI=.91, IFI=.91, AGFI=.87, GFI=91, RMSEA=.08, NFI=.90, and TLI=.90. In the measurement model, the GFI value indicates a good fit, and the X^2/df, CFI, IFI, AGFI, RMSEA, TLI, and NFI values indicate an acceptable fit.

Figure 1

Confirmatory factor analysis model of the AI-TPACK scale



Convergent Validity: For convergent validity, the composite reliability (CR) value and the average explained assumption (AVE) value are considered. Some sources require an AVE value above .50 (Shrestha, 2021) and the CR > AVE condition (Hair et al., 2014). However, convergent validity is considered to be achieved if the AVE value is less than .50 and the CR value is greater than .60 (Fornell & Larcker, 1981; Shrestha, 2021).

Table 4

Convergent Validity of AI-TPACK Scale

AI-TPACK	*CR*	*AVE*
Scale Total	.88	.38

According to Table 4, the CR value for the overall scale was above .80. High CR values for the overall scale and its subscales indicate good internal consistency reliability. Based on these results, it can be said that the scale achieved convergent validity.

Item Discrimination

One of the methods for examining the reliability of a data collection tool is to compare upper and lower groups. The test is expected to distinguish between participants who possess and do not possess the desired characteristic. For this purpose, total scores are ranked from highest to lowest, and the 27% groups are divided into lower and upper groups. To assess the scale's internal validity, an independent samples t-test was used to examine the significance of the differences between the lower and upper 27% groups. The means of these two groups were then compared using an independent samples t-test. A significant analysis indicates that the test has high discriminative power (Can, 2020). In this study, 90 participants with the lowest and highest scores were divided into lower and upper groups. For the AI-TPACK Scale, the mean score of the upper group was 41.63, and the mean score of the lower group was 22.19.

Table 5

Independent Samples t-Test for Lower and Upper Groups of the AI-TPACK Scale

Scale	*Group*	*N*	*Mean*	*Sd*	*t*	*p*
AI-TPACK	Lower Group	85	22.19	5.89	-22.25	00*
	Upper Group	85	41.63	5.06		

$N_{Lower\%27}=85$ *and* $N_{Upper\ \%27}=85$

When Table 5 is examined, a statistically significant difference was found between the AI-TPACK Scale scores of the lower and upper groups ($p<0.01$). In this context, the scale can be said to be highly reliable.

Criterion Validity of AI-TPACK

Data collected from a sample of 316 students was examined to assess the criterion validity of the AI-TPACK Scale. In this context, the relationships between the total AI-TPACK Scale score and AI Attitude were examined utilising Pearson correlation analysis.

Table 6

Descriptive Statistics and Correlation Analysis Results of the AI-TPACK Scale

Variables	*N*	*Mean*	*Sd*	*1*	*2*
1.AI-TPACK	316	3.75	0.48		
2.AI ATTITUDE	316	6.95	1.38	. 33**	

*$p<0.05$, **$p<0.01$

Table 6 reveals a positive and significant relationship between the AI-TPACK Scale and AI Attitude (r = .33). These findings indicate that the AI-TPACK Scale meets criterion validity.

Findings Related to Reliability Analyses

McDonald's Omega and Cronbach's Alpha internal consistency tests were employed to determine the reliability of the AI-TPACK scale. The findings are presented in Table 7.

Table 7

AI-TPACK Scale Cronbach Alpha and McDonalds Omega Values

Scale	*Cronbach Alfa (a)*	*McDonalds Omega (ω)*
AI-TPACK	.88	.88

Table 7 reveals that Cronbach's alpha and McDonald's Omega values for the AI-TPACK scale are 0.88. The measurement results demonstrate that the AI-TPACK Scale is a reliable measurement tool.

Discussion

The role of technological and pedagogical knowledge in educational activities has become increasingly important since the early 21st century. In the last 4-5 years, the development of AI tools has made AI-TPACK competence necessary. In particular, teachers' AI-TPACK skills make it easier for them to carry out teaching activities effectively and efficiently (Çelik, 2023). Therefore, AI-TPACK scales are needed to understand the effects of teachers' AI-TPACK competencies. The purpose of this study is to adapt the AI-TPACK Scale (Hojeij et al., 2024) to Turkish culture. The findings of the study, which consisted of teachers, indicate that the Turkish form of the AI-TPACK Scale is functional and usable. Reliability analysis results showed that the Cronbach's Alpha and Omega values of the AI-TPACK Scale were .88. Similarly, the internal consistency coefficient was determined to be .95 in the study in which the scale was developed (Hojeij et al., 2024). According to the analysis results, the reliability values of the AI-TPACK Scale were proven to be at a good level.

The item-total correlation values of the AI-TPACK Scale were found to range between .41 and .66. The item factor loadings of the scale were found to range between .48 and .72. Therefore, since these values are above .30, it can be said that they are at an acceptable level (Cohen, 1988; Büyüköztürk, 2018). According to the convergent validity analysis results of the AI-TPACK Scale (AVE=.38, CR=.88), convergent validity was observed. According to the literature, convergent validity is accepted even if the AVE value is less than 0.50, if the CR value is greater than 0.70 (Dede, 2019, p. 1935). In the present study, although the AVE value was unexpectedly below 0.50, the CR > AVE criterion was met. Furthermore, the CR value was calculated as 0.88, which is above 0.70. According to the CFA results, the scale fit indices were found to be at an acceptable level. The fact that scale fit indices are at an acceptable level rather than a good level can be explained in the context of the participant group. The characteristics of the participants or the number of participants is important. Indeed, these cutoff scores are affected by the sample size (Sarıçam & Günaydın, 2024). The 27% upper-lower group analysis findings also indicate that item discrimination was achieved (Can, 2020). All analyses conducted on the AI-TPACK Scale have proven that the Turkish form of the scale, consisting of 12 items and a single dimension, is valid and reliable. Therefore, it is expected that the AI-TPACK Scale translated into Turkish will contribute to an in-depth understanding of the reasons and consequences of teachers' AI-TPACK competencies in future studies.

The AI Attitude Scale was used to test the criterion validity of the AI-TPACK Scale. Correlation analysis results showed that there were significant positive relationships between AI-TPACK and AI attitudes. According to this finding, which is consistent with the literature (Xu et al., 2025), individuals' positive

attitudes towards AI can play a role in the development of AI-TPACK competencies. However, the low level of this correlation coefficient may be due to participants having a negative attitude towards AI. Similarly, Erol et al. (2025) did not find a relationship between negative attitudes towards AI and AI-TPACK. Furthermore, a similar and close correlation (r=0.45) was found between positive attitudes towards AI and AI-TPACK (Erol et al., 2025). Indeed, individuals' AI attitudes and self-efficacy are known to be determinants of AI acceptance and use (Türk et al., 2025). In particular, teachers' perceived usefulness and ease of use of AI have significant positive relationships with AI-TPACK competencies (Runge et al., 2025). Furthermore, one of the ways to increase teachers' AI-TPACK competencies is to strengthen their digital competencies (Hava & Babayiğit, 2025). In conclusion, studies in the literature and the results of this study indicate that teachers' technological and pedagogical knowledge plays a critical role in the integration of AI into education (Çelik, 2023). Education systems worldwide are constantly being updated in line with AI. Similarly, in Turkey, the Ministry of National Education attaches importance to the integration of AI into education in order to improve educational standards (İşler & Kılıç, 2021). Studies that address education and AI together can be an important resource for researchers and practitioners (İncemen & Öztürk, 2024). In this context, the scale adapted in the current research is a current and functional scale used to measure teachers' AI-TPACK competence. Furthermore, this study has brought together two different disciplines, AI and TPACK. In addition, thanks to its low number of functional items, the scale is expected to be more functional and applicable in terms of time and energy compared to other similar scales.

Although this scale adaptation study enriches the AI-TPACK literature, it has some limitations. The gender, age range, branch, and level of instruction of the study participants were evenly distributed. However, the majority of the study data consisted of teachers in public schools in the eastern region of Turkey. The original study developing the AI-TPACK Scale consisted of private school teachers (Hojeij et al., 2024). Therefore, future studies to increase the generalizability and utility of the AI-TPACK Scale could be conducted with teachers working in the western region of the country and in private schools. Furthermore, the majority of teachers in this study work at the high school level. This indicates that the participants were not evenly distributed according to school level. Collecting research data using self-report instruments may lead to inherent method biases. This limitation can be addressed in future studies by using observations and semi-structured interviews. The study utilized several different analyses of reliability and validity. Furthermore, Rasch analysis and measurement invariance analyses could be used in future studies. Additionally, in the CFA process, the low AVE value, the acceptability of the fit indices, and the use of a single scale for criterion validity are also limitations. The AI-TPACK scale was developed in the United Arab Emirates and adapted to Turkish culture. Future studies could be conducted in Western countries with diverse languages and cultures. This would ensure the scale's global usability, allowing for cross-cultural comparative studies on AI-TPACK.

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