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RESEARCH ARTICLE

Adaptation of the Interactive, Constructive, Active and Passive Technology Scale: Validity and Reliability Study

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What is already known on this topic?

- *Technology integration is recognized as a prerequisite for active, collaborative, and constructivist learning in 21st-century education, moving beyond mere access to digital tools.*
- *Most existing scales in the Turkish literature focus on teachers' self-efficacy, attitudes, or technology acceptance, often validated through samples of pre-service teachers rather than active practitioners.*
- *The ICAP (Interactive, Constructive, Active, Passive) framework provides a robust theoretical basis for categorizing the cognitive engagement levels of students during technology-enhanced learning activities.*

Abstract

The aim of this study is to adapt the scale developed by Antonietti et al. (2023), which evaluates teachers' technology integration according to the ICAP (interactive, constructive, active, passive) theoretical framework, into Turkish. The study group consists of 274 teachers working at various educational levels in Türkiye. As part of the scale adaptation process, linguistic equivalence studies were initially conducted, followed by confirmatory factor analysis to ensure construct validity.The analysis results revealed that the scale's structure—consisting of 12 items and four subscales (passive, active, constructive, and interactive)—is also valid within the Turkish context ($X2/df$) = 2.482, root mean square error of approximation = 0.074, normed fit index = 0.947, relative fit index = 0.927, comparative fit index = 0.967, Tucker–Lewis index = 0.955). In this framework, the passive dimension measures technology usage behaviors where the student is in a receptive role; the active dimension assesses the processing of information; the constructive dimension measures the generation of new meanings; and the interactive dimension evaluates the occurrence of collaborative processes. The reliability of the scale was examined using cronbach's alpha internal consistency coefficient, which indicated a high level of reliability (α = 0.919). Furthermore, it was observed that all average variance extracted values exceed 0.50 and composite reliability values exceed 0.70, thereby ensuring the convergent validity of the scale. In conclusion, this study demonstrates that the Turkish version of the scale is a valid and reliable measurement tool capable of assessing teachers' technology integration practices in a multidimensional manner.

Keywords: Reliability, scale adaptation, technology integration, teacher education, validity

Introduction

The integration of technology into teaching is indispensable in 21st-century educational environments. The use of technology in education has emerged because of a paradigm shift, particularly in the first half of the 21st century, with the aim of both increasing access to education and improving the quality of teaching. The integration of technology into teaching environments is now considered a prerequisite for active, authentic, collaborative, and constructivist learning (Kanti Halder, 2023). When considering teaching competencies in this context, simply being knowledgeable in one's subject area or having a good understanding of the psychological state of the target age group, in other words, possessing good pedagogical content knowledge, has been replaced over time by "technological pedagogical content knowledge," which requires combining general pedagogical knowledge, subject knowledge, and technology (Harris & Hofer, 2009). The changes brought about by the integration of technology into education have also transformed the concept of the student into that of the digital learner (Akram et al., 2022).

The potential of using digital technology in teaching is related not only to which technologies are used and how often, but also to how technology cognitively stimulates students and ensures their mental participation in learning activities. For this reason, it is necessary to understand technology integration models in education and develop the ability to use technology in a way that maximizes learning (Kanti Halder, 2023). The models in question are explained at three levels. The first is the displacement level, where technology only provides environmental change; the second is the enhancement level, where technology provides facilitation; and finally, the transformation level, where technology changes classroom routines and provides deep learning (Ardıç, 2021).

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What this study adds on this topic?

- *This study provides a culturally and linguistically validated Turkish version of the "ICAP Technology Scale," offering a multidimensional tool to assess how active teachers integrate technology into their lessons.*
- *Unlike traditional self-efficacy scales, this instrument specifically evaluates technology integration through the lens of student cognitive engagement, confirming a four-factor structure (passive, active, constructive, and interactive) in the Turkish context.*
- *The findings offer a reliable measurement tool for researchers and policymakers to monitor the transition from traditional "displacement" levels of technology use to more "transformative" and high-level cognitive engagement practices in classrooms.*

If the goal in teaching is to stimulate the learner cognitively and ensure their mental engagement in the lesson through collaborative and constructivist learning, then technology integration should be targeted at the second and third levels. In other words, the key is not to use technology in place of traditional teaching for subjects that can be taught using traditional methods, but rather to use technology as a facilitator and transformative tool in challenging learning activities. For this reason, it is important to measure teachers' experiences with digitalization in teaching. In fact, perhaps what needs to be done is to aim for teachers, even when they are still teacher candidates, to be able to use technology integration in teaching at advanced and transformative levels in courses related to professional knowledge and practice.

A review of the literature reveals that technological pedagogical content knowledge (TPACK) self-efficacy studies have been conducted with education faculty students who will become teachers at almost every level. In fact, some studies have also addressed technology integration models in teacher education (Kaya et al., 2013). The importance of TPACK in teacher education, or in other words, the integration of technology for more effective teaching, stems from the fact that a candidate's TPACK determines their tendency to use technology in teaching (Sofwan et al., 2023). In a modern education faculty, all teaching staff should be highly proficient in using technology at every level and should create learning environments that enable teacher candidates to use it as well.

Kaya et al. (2013) stated that it is difficult to say that the country has yet to meet the desired level of 21st-century education standards in the field of teacher training. However, studies conducted over the past five years have shown improvement in this regard. For example, Gökbulut et al. (2021) found that academics working in education faculties had high digital material design competencies, while teachers had moderate digital material design competency levels. Other studies focusing on teachers have reported relatively complex findings, such as high levels of information technology use among primary school teachers (Şengür & Anagün, 2021); greater willingness among Social Studies teachers with extensive professional experience to recognize and address their shortcomings and to engage in collaboration, which in turn enables more effective use of instructional technologies (Erdoğan & Şerefli, 2021); and the highly limited autonomy of mathematics teachers in the context of technology use, who tend to employ technology statically and are often unable to support students' actions beyond traditional paper-and-pencil environments (Bozkurt, 2022). Therefore, although progress has been made in recent years in terms of technology and digitalization, the fact that most teachers demonstrate moderate or limited proficiency suggests that there is still work to be done for teachers and teacher candidates.

The integration of educational technologies into teaching processes is closely related to teachers' perceptions of self-efficacy and their attitudes toward technology. In this context, various scales have been developed in the literature to assess teachers' technology integration and perceptions of self-efficacy, and these have been adapted into Turkish and incorporated into educational research.

For example, the "Self-Efficacy Perception Scale for Technology Integration" was developed by Wang, Ertmer, and Newby (2004) and adapted into Turkish by Ünal and Teker (2018), with validity and reliability studies conducted on teacher candidates. According to the results of exploratory factor analysis (EFA), the scale is two-factorial, and these factors explain 55.36% of the total variance. The first factor of the scale consists of 16 items and is named Computer Technology Competence, while the second factor consists of five items and is named External Factors Affecting Computer Use. The reliability of the scale was calculated using Cronbach's α internal consistency coefficient and found to be 0.94. Similarly, the "Technology Acceptance Measure for Teachers (T-TAM)" was developed by Ursavaş, Şahin, and McIlroy (2014) and measures teachers' attitudes, perceptions, and behavioral intentions toward technology use. The scale comprises 38 items and is divided into 11 subscales.

These sub-dimensions are perceived usefulness, perceived ease of use, attitude toward use, subjective norm, self-efficacy, facilitating conditions, technological complexity, anxiety, perceived enjoyment, appropriateness, and behavioral intention. Cronbach's α coefficients for the factors included in the scale ranged from a minimum of 0.798 to a maximum of 0.909. Another scale used for teacher candidates on the same subject is the "Technological Pedagogical Content Knowledge-TPACK-ISTE Self-Efficacy Scale." The scale was developed and adapted into Turkish to assess teacher candidates' self-efficacy in TPACK within the framework of the ISTE teacher standards (2008). The scales mentioned above are recognized in the literature as important tools for measuring teachers' perceptions of self-efficacy and acceptance levels in the technology integration process.

Recent studies have also reinforced the importance of scales in this field. For example, a meta-analysis by Zeng, Wang, and Li (2022) showed a strong relationship between teachers' technology integration self-efficacy and their levels of Technological Pedagogical Content Knowledge (TPACK). Dinçer, Polat, and Dinçer's (2024) study examined the interaction between English as a Foreign Language (EFL) teachers' TPACK and technology integration self-efficacy in Türkiye and revealed that self-efficacy beliefs significantly predicted TPACK competencies. Furthermore, the study by Çebi and Reisoğlu (2023) demonstrated that teachers' digital competencies can be measured validly and reliably through the adaptation of the "Digital Competence for Educators" scale developed by the European Commission into Turkish.

The common feature of the scales mentioned so far is that they are designed to measure teachers' perceptions of self-efficacy and acceptance levels in the technology integration process. Most scales have been adapted for use in educational research through Turkish adaptation studies and are supported by validity and reliability analyses. However, most of the existing scales have been tested on teacher candidates.

More studies are needed on teachers' integration of technology into their lessons. This study aims to examine the validity and reliability of the "ICAP Technology Scale," developed by Antonietti et al. (2023), following its adaptation to Turkish culture, to address the question: "Can the adapted scale be used as a valid and reliable measurement tool?" In this context, analyses will be conducted on linguistic validity, construct validity, and reliability. The scale selected for the study differs from previous scales in terms of sampling and the structural context within which it is applied. It is believed that the selected scale, regardless of discipline, will provide a unique contribution to the literature in terms of its applicability in the context of teacher education.

Method

This research is a scale adaptation study. Accordingly, the study includes the steps of scale adaptation. Analyses related to linguistic validity, construct validity, reliability, and convergent validity were conducted in the study.

The Starting and Finishing Date of the Study

The study began in November 2024 and was completed in January 2026.

Study Group

Within the scope of the research, the measurement tool was applied to teachers who use technology in their lessons, regardless of their field. As a result of the analysis conducted during the sample size determination process, the total sample size was calculated to be at least 200 individuals using "A-priori Sample Size Calculator for Structural Equation Models" (Soper, 2026). (High impact factor (0.5), and significance level of .01). The general consensus in the literature is that even for the simplest confirmatory factor analysis (CFA) models, the sample size should be ten times the number of items (Kline, 2023). Accordingly, the sample size of 274 individuals obtained for the 12-item scale structure was deemed sufficient for CFA. Demographic information for the study group is reported in the findings section.

Data Collection Tool

The ICAP Technology Scale: Developed by Antonietti et al. (2023), the scale is designed to assess how technology is integrated into lessons. The scale development study was conducted with 1059 teachers from Switzerland. The scale consists of 12 items that describe the integration of technology in different learning activities carried out in lessons by teachers and students. The items consist of four subscales reflecting interactive, constructive, active, and passive learning activities supported by technology according to the ICAP classification.

The passive dimension of the scale assesses behaviors related to individuals passively following learning material without engaging in any interaction. This dimension is measured by items 1, 2, and 3 of the scale. The active dimension encompasses the learner's behaviors aimed at processing information by interacting with the material presented, and items 4, 5, and 6 of the scale correspond to this dimension. The constructive dimension reflects the individual's tendency to go beyond existing knowledge to produce new meanings, establish connections, and make inferences. This dimension is measured by items 7, 8, and 9 of the scale. The interactive dimension assesses learners' participation in cognitive interaction processes based on mutual exchange of information with peers, joint meaning-making, and collaboration. This dimension is represented by items 10, 11, and 12 of the scale.

The Cronbach's α value for the passive subscale is 0.83, for the active subscale it is 0.89, for the constructive subscale it is 0.87, and for the interactive subscale it is .90. The Cronbach's α reliability coefficients for the four subscales range from 0.83 to 0.90. For each item, teachers were asked to indicate how often they and their students used technology to carry out the activities described in the items. Responses were given on a 5-point Likert scale ranging from "Almost never" (0) to "Almost every lesson" (4). First- and second-order CFA was conducted to examine the structural validity of the ICAP Technology Scale. For the first-order CFA, $X^2/df=4.08$, comparative fit index (CFI) = 0.980, Tucker–Lewis index (TLI) = 0.971, root mean square error of approximation (RMSEA) = 0.061, and SRMR = 0.028 were found. For the second-order CFA, $X^2/df=4.06$, CFI = 0.980, TLI = 0.972, RMSEA = 0.054, and SRMR = 0.028. Standardized factor loadings ranged from 0.669 to 0.915, and the items represented the factors well. The study concluded that the scale was valid and reliable.

Personal Information Form: The personal information form prepared by the researchers contains various questions regarding participants' demographic information and digital technology usage habits. The form collects information on participants' gender, the amount of time they spend using digital technologies in their daily lives, the amount of time they spend using digital technologies in class, the learning processes and stages in which they use digital technologies during class, and the names of the digital technologies they use in class.

Data Collection

The scales used in the study were administered by the researcher to teachers who volunteered to participate. Prior to administration, participants were informed about the purpose of the study and instructed on how to complete the scales. The data collection process was conducted using both online and face-to-face methods. Some teachers completed the scales online via Google Forms, while others responded using printed forms. In both cases, it took an average of 20 minutes to complete the scales.

Data Analysis

In the analysis of the data, statistical procedures were first performed to evaluate the scale's linguistic equivalence, construct validity, and reliability properties. Within the scope of linguistic equivalence, the relationship between the scores obtained from the English and Turkish versions of the scale was examined using Pearson correlation analysis.

In this study, EFA was not applied during the validity analysis process; instead, CFA was performed directly. The main reason for this is that the adapted measurement instrument (ICAP Technology Scale) is based on a strong theoretical foundation, and its sub-dimensions are clearly defined beforehand within this theoretical framework. The relevant methodology literature (Kline, 2023; Tabachnick & Fidell, 2007) emphasizes that when adapting standard measurement instruments with predefined dimensions and theoretical backgrounds to different cultures or samples, instead of operations aimed at rediscovering the factor structure (EFA), CFA approaches that test the validity of the existing theoretical model on the new dataset should be used. Accordingly, the factor structure, consistent with the scale's original theoretical framework, was tested and validated using CFA.

To determine the validity of the structure, the data set was evaluated in terms of outliers and normal distribution; then, the

Kaiser–Meyer–Olkin (KMO) coefficient was calculated to determine the suitability of the sample for factor analysis, and CFA was applied.

The fit indices obtained from the CFA revealed that the model was acceptable and showed good fit after modifications. The reliability of the scale was assessed using Cronbach's alpha internal consistency coefficients; its convergent validity was tested based on average variance extracted (AVE) and composite reliability (CR) values. Finally, the relationships between the scale's subscales and the total score were examined using Pearson correlation analysis.

Publication Ethics

This study was conducted in accordance with scientific publication ethics. Participants were asked to sign an informed consent form as part of the research. An ethics committee report was obtained from Fatih Sultan Mehmet Vakıf University Ethics Committee (Date: November 7, 2024 Number: 41/16)

Results

Descriptive statistics regarding the demographic characteristics of the participants and their technology usage are presented in Table 1.

Table 1 shows that 68.6% (N = 188) of the teachers participating in the study were female, while 31.4% (N = 86) were male. Regarding technology usage within the scope of the course, 20.4% of participants (N = 56) stated that they always use technology, 53.6% (N = 147) stated that they mostly use it, 24.5% (N = 67) stated that they sometimes use it, and 1.5% (N = 4) stated that they rarely use it. When asked at which stage of the lesson they used technology, 20.1% (N = 55) stated they used it at the beginning of the lesson, 72.6% (N = 199) stated they used it during the lesson, and 7.3% (N = 20) stated they used it at the end of the lesson.

When asked about technology usage according to the stages of the lesson, 27.7% of teachers (N = 76) stated they used it for attention-grabbing, 12.4% (N = 34) for discovery, 20.8% (N = 57) for explanation, 36.9% (N = 101) for deepening, and 2.2% (N = 6) for evaluation. Additionally, when participants were asked about their use of technology in daily activities throughout the day, 31.4% (N = 86) stated they always use it, 59.9% (N = 164) stated they use it most of the time, and 8.8% (N = 24) stated they use it sometimes.

Table 1.
Participants' Demographic Characteristics and Technology Usage Status

Gender	Frequency	Percentage (%)
Woman	188	68.6
Man	86	31.4
Time spent using technology during class		
Always	56	20.4
Most of the time	147	53.6
Sometimes	67	24.5
Rarely	4	1.5
The learning process in which they use technology		
The beginning of the lesson	55	20.1
During the lesson	199	72.6
At the end of the lesson	20	7.3
Technology usage according to the stages of the lesson		
Attention	76	27.7
Discovery	34	12.4
Explanation	57	20.8
Deepening	101	36.9
Evaluation	6	2.2
Technology usage in daily activities throughout the day		
Always	86	31.4
Most of the time	164	59.9
Sometimes	24	8.8

Table 2.
Skewness and Kurtosis Values for the ICAP Technology Scale

Item	Skewness	Kurtosis
Item 1	−0.786	0.187
Item 2	−0.602	−0.235
Item 3	−0.703	−0.483
Item 4	−0.247	−0.885
Item 5	−1.004	0.646
Item 6	−0.668	−0.225
Item 7	−0.859	−0.018
Item 8	−0.776	−0.286
Item 9	−0.772	−0.403
Item 10	−0.724	−0.348
Item 11	−0.607	−0.605
Item 12	−0.611	−0.455

Linguistic Validity

When adapting the (ICAP Technology Scale) into Turkish, permission was first obtained via email from Antonietti, one of the responsible authors. The original scale was translated by researchers and submitted to five subject matter experts proficient in both English and Turkish for their opinions using the "Translation Evaluation Form." In two pilot studies involving 50 participants, the clarity and comprehensibility of the scale items were evaluated. Subsequently, the original English version of the scale was administered to 50 English-literate students, followed by the Turkish version of the scale three weeks later, and correlation analysis was performed to determine whether there was a relationship between these two applications. A high level of positive correlation was found between the English form and the Turkish form (r = .84, p < .001).

Structural Validity and Reliability

To test the construct validity of the scale, the data set was first examined for the presence of outliers and the normality of the data distribution. No outliers were found in the data. To test the suitability of the data for normal distribution, skewness and kurtosis values were examined. As shown in Table 2, skewness and kurtosis values between −2 and +2 indicate that the data are normally distributed (Tabachnick & Fidell, 2007). According to Table 2, data are normally distributed. The KMO test value calculated to determine whether the sample is suitable for factor analysis was 0.894. Subsequently, the CFA stage was conducted. The CFA (X^2/df)= 2.482, RMSEA = 0.074, normed fit index (NFI) = 0.947, relative fit index (RFI) = 0.927, CFI = 0.967, TLI = 0.955) showed acceptable fit (Hu & Bentler, 1999). The model is presented in Figure 1. Furthermore, to justify the calculation of a total scale score, a second-order CFA was conducted. The results of the second-order CFA also demonstrated a good fit to the data, confirming that the subdimensions validly converge under a single overarching construct (X^2/df) = 2.714, RMSEA = 0.07, NFI = 0.940, RFI = 0.906, CFI = 0.961, TLI = 0.938). The model is presented in Figure 2.

For items to be included in the scales, their factor loadings must be greater than 0.30 (Büyüköztürk, 2004). As shown in Figure 1, the factor loadings of the four-factor model are greater than 0.30. Therefore, it can be said that the scores of the 12 items included in the scale measure the underlying constructs that form the structure of the ICAP Technology Scale, as hypothesized, and in other words, that the scale's factorial validity is established. Cronbach alpha internal consistency

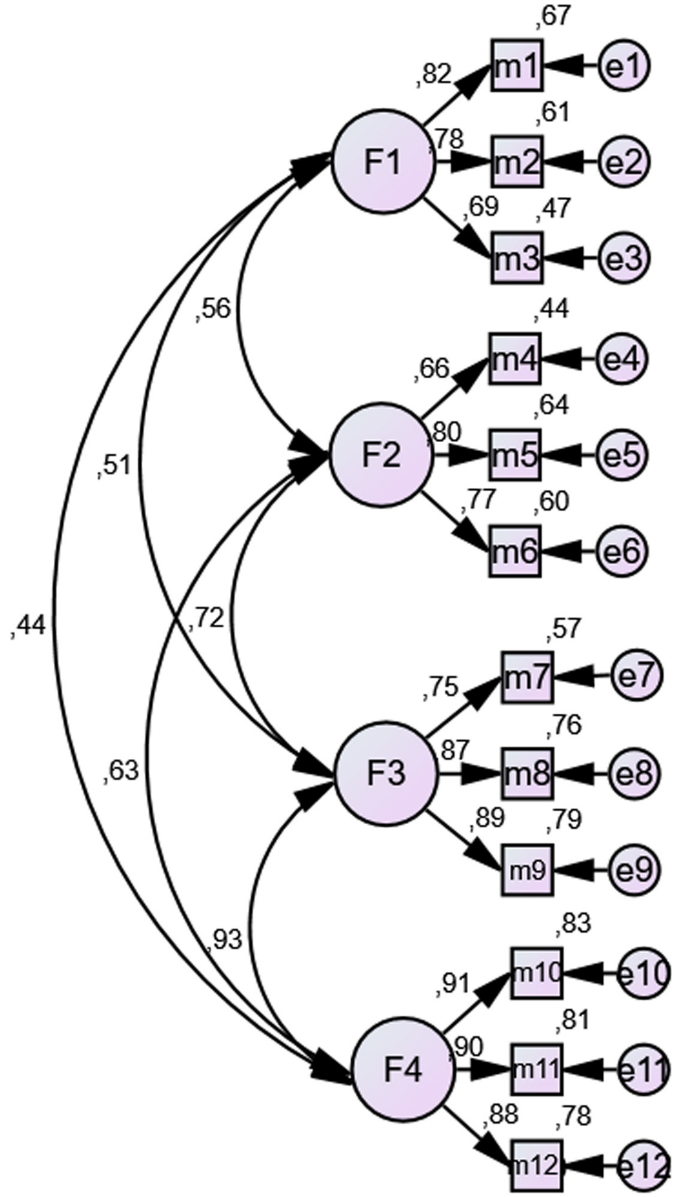

Figure 1. CFA Model.

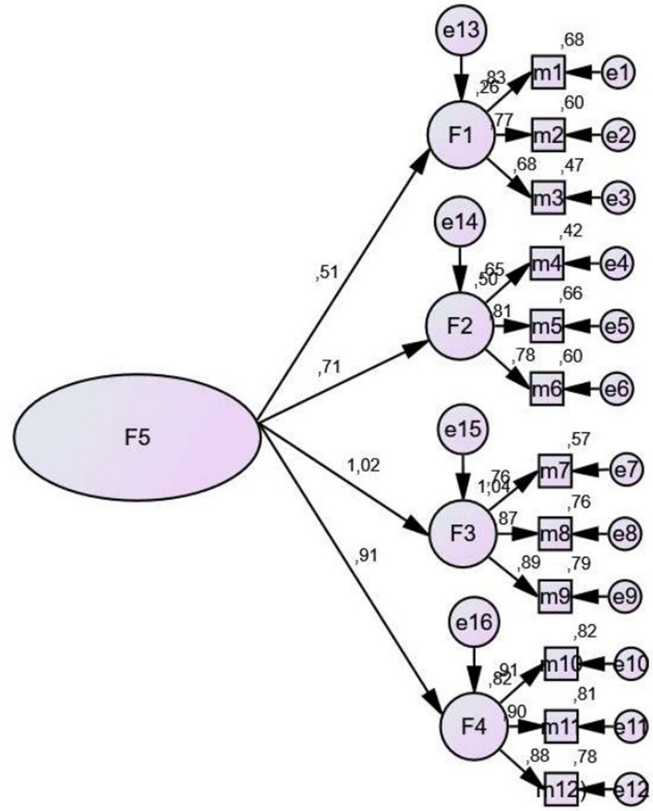

Figure 2. Second Level CFA Model.

coefficients, AVE, and CR values for the subscales of the ICAP Technology Scale are presented in Table 3:

Table 3 shows that the Cronbach α values were 0.813 for the passive dimension, 0.757 for the active dimension, 0.876 for the constructive dimension, 0.924 for the interactive dimension, and 0.919 for the overall scale. As the Cronbach's α coefficient approaches 1, it is concluded that the internal consistency of the items included in the scale is high (Yang and Green, 2011). When examining the values, it was concluded that the scale is reliable. It is stated that convergent validity is achieved if the AVE value is greater than 0.50 and the CR value is greater than 0.70 (Schermelleh-Engel et al., 2003). Looking at the values in Table 3, it can be seen that all AVE values are greater than 0.50, while CR values are greater than 0.70. In this case, the convergent validity of the scale is ensured. Correlations between the ICAP Technology Scale and subscales are presented in Table 4. Table 4 shows that all sub-dimensions correlate significantly with each other and with the scale as a whole.

Discussion and Conclusion

The study found that the ICAP Technology Scale, which aims to measure how teachers integrate technology into their teaching processes, is a valid and reliable measurement tool in the Turkish context. Accordingly, it was concluded that the scale can be successfully applied in Turkish culture. The Turkish version of the ICAP Technology Scale yielded robust results in terms of construct validity and reliability. The linguistic adaptation process of the scale was carried out with great care; as a result of translation, expert reviews, and pilot studies, it was determined that the scale items were clear and understandable to the Turkish teacher sample. The strong and statistically significant correlation between the English and Turkish forms confirmed the linguistic equivalence of the scale.

Preliminary analyses indicated that the data were highly suitable for factor analysis. Subsequently, CFA results demonstrated that the original four-factor structure of the scale was successfully preserved in the Turkish sample. The model exhibited good fit values according to the accepted criteria in the literature (Hu & Bentler, 1999), firmly establishing the structural validity of the Turkish form. Furthermore, internal consistency analyses revealed high reliability coefficients for all sub-dimensions—namely the passive, active, constructive, and interactive dimensions—as well as for the overall scale (Yang & Green, 2011). The convergent validity of the scale was also supported, as the relevant

Table 3.
Cronbach Alpha, AVE, and CR Values for the Sub-dimensions of the ICAP Technology Scale

Sub-dimensions	**Cronbach α**	**AVE**	**CR**
Passive	0.813	0.58	0.81
Active	0.757	0.56	0.79
Constructive	0.876	0.68	0.87
Interactive	0.924	0.79	0.92
ICAP	0.919		

Note: AVE=Average variance extracted; CR=Composite reliability; ICAP=Interactive, Constructive, Active, Passive.

Table 4.
Correlations Between the ICAP Technology Scale and Its Subscales

		1.	2.	3.	4.	5.
1. Passive	Pearson correlation	1	0.479**	0.446**	0.390**	0.666**
	Sig. (2-tailed)		0.000	0.000	0.000	0.000
	N	274	274	274	274	274
2. Active	Pearson correlation	0.479**	1	0.612**	0.560**	0.803**
	Sig. (2-tailed)	0.000		0.000	0.000	0.000
	N	274	274	274	274	274
3. Constructive	Pearson correlation	0.446**	0.612**	1	0.829**	0.904**
	Sig. (2-tailed)	0.000	0.000		0.000	0.000
	N	274	274	274	274	274
4. Interactive	Pearson correlation	0.390**	0.560**	0.829**	1	0.880**
	Sig. (2-tailed)	0.000	0.000	0.000		0.000
	N	274	274	274	274	274
5. ICAP Technology Scale	Pearson correlation	0.666**	0.803**	0.904**	0.880**	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	
	N	274	274	274	274	274

ICAP = Interactive, Constructive, Active, Passive.
**stands for $p < .01$

average variance and CR metrics fully met the required threshold values (Schermelleh-Engel et al., 2003).

The meaningful correlations of the subscales with each other and with the entire scale demonstrate its structural integrity, indicating that the measured concept is cohesive and relies on a single superstructure. During the translation process, while some expressions were culturally adapted to align with the Turkish education system and teachers' technology usage habits, the theoretical core of the scale remained unaltered. This confirms that the scale can accurately assess teachers' technology integration levels within the Turkish cultural context. Ultimately, the findings of this adaptation study largely align with those of the original scale developed by Antonietti et al. (2023), reflecting similarly strong fit indices. The item factor loadings comprehensively satisfied the acceptability criteria, successfully representing the hypothesized four-dimensional structure. This consistency supports the conclusion that the conceptual integrity of the ICAP Technology Scale is maintained independently of the cultural context.

When examining previous studies on technology integration, it is observed that the research generally focuses on the frequency of technology use, teachers' self-efficacy perceptions, or their level of TPACK (Dikmen and Demirer, 2016; Gökbulut and Gürtepe, 2024; Kabakçı Yurdakul, 2011; Şimşek and Yazar, 2018; Topal Altındiş and Yaman, 2021; Wang, Ertmer, and Newby, 2004). Although research has found that teachers have a high level of self-efficacy regarding technology integration (Birişçi and Kul, 2018), it has been revealed that in practice, teachers are unable to use these tools effectively and exhibit a teacher-centered approach (Bulut and Koçoğlu, 2012; Çoklar and Kabakçı Yurdakul, 2017; Dinçer, Şenkal, and Sezgin, 2013; Türel and Johnson, 2012).

The adapted scale is important in that it allows teachers to directly measure the cognitive participation level (ICAP) at which they integrate technology into their teaching processes. Because the effective integration of technology into teaching is not about how often technology is used, but rather the context in which it is used (Tezci, 2016). In this regard, the adapted scale fills a theoretically grounded gap in quantitative research by targeting the quality of integration (Antonietti et al., 2023).

The ICAP Technology Scale is a tool that measures how technology is integrated into the teaching process, as opposed to how much technology is used in the teaching process. In this measurement process, students' cognitive participation levels (ICAP) are taken as a basis. In this regard, the scale adaptation has also provided the Turkish literature with a theoretical framework for cognitive participation. The adapted scale provides an opportunity to measure the extent to which teachers guide students from passive learning activities to constructivist and interactive learning processes by integrating technology (Antonietti et al., 2023). Research on technology integration in Türkiye has found that most teachers use technology at the "substitution" level as a tool, while very few teachers achieve integration at the "transformation" level, where active student participation exists (Ardıç, 2021). This result demonstrates how important findings obtained through tools such as the ICAP Technology Scale are for understanding the level of technology integration at the application level, rather than the frequency of technology use by teachers.

When theoretically considered, the ICAP Technology Scale shows that the ICAP model, consisting of four factors, maintains its unique structure in Turkish culture in terms of cognitive participation levels (ICAP). This protective condition reflects the cross-cultural universality of cognitive engagement levels. This reflection also indicates that teachers from different cultures essentially categorize technology-supported activities in their teaching processes into the same four structures.

The results obtained from the ICAP Technology Scale also indicate teachers' pedagogical competencies. High scores on the scale indicate that teachers also have a high level of pedagogical design capacity, which reflects their ability to predict and plan students' interaction with technology in advance. At the same time, high scores on the constructivist and interactive subscales provide concrete evidence of teachers' TPACK competence (Weinhandl et al., 2025).

Recommendations

Based on the results obtained, the following can be recommended for future research:

Future studies could utilize the scale to investigate the evolution of instructional technology use in post-pandemic classrooms. Specifically, researchers can explore whether the mandatory adoption of digital tools during the COVID-19 era has successfully transitioned into a planned, pedagogical integration that actively fosters students' cognitive engagement. To further expand the literature, researchers are encouraged to explore the correlational and predictive relationships between teachers' technology integration levels—as measured by this scale—and other essential professional constructs, such as TPACK, technology integration self-efficacy, and professional commitment. Methodologically, advanced structural equation modeling or item response theory approaches could be employed to empirically test the hierarchical nature of the ICAP framework (progressing from passive to interactive). This would also help verify whether the cognitive difficulty ranking of these levels remains consistent within the Turkish educational context. From a practical perspective, school administrators and educational policymakers can employ this validated tool to diagnose teachers' current technology integration profiles. The insights gained can be directly utilized to design targeted, needs-based professional development programs that guide teachers from passive technology users toward becoming interactive facilitators.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

Artificial Intelligence Usage Statement: This study used ChatGPT to improve language and edit grammar during the preparation of the manuscript. The authors declared

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