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Artificial Intelligence Assisted Instructional Design Readiness Scale for Teacher Candidates: Development and Validation

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Abstract
Artificial intelligence technologies reshape instructional design processes not only technically but also pedagogically and ethically. In this context, determining the readiness levels of pre-service teachers for this process is critical for the development of contemporary teacher competencies. The aim of this study is to develop a valid and reliable scale to measure the readiness levels of pre-service teachers towards artificial intelligence-supported instructional design. In this quantitative research design, exploration and confirmatory factor analyses and reliability studies were conducted in line with the scale development process. The first application was conducted with 325 pre-service teachers and the confirmatory application was conducted with a different sample of 256 students. The developed scale consists of 32 items in total and four sub-dimensions: Cognitive Readiness, Affective Readiness, Technological Integration Competence and Perceptual Confidence. The construct validity was proved by exploration and confirmatory factor analyses and Cronbach's Alpha reliability coefficients were quite high in both samples. The findings show that pre-service teachers are highly prepared for artificial intelligence-supported teaching processes. This scale can be considered as a functional tool in restructuring teacher education programs, planning in-service trainings and evaluating teacher competencies.

Keywords: Artificial Intelligence-Supported Instruction, Readiness, Pre-Service Teachers, Scale Development

1. Introduction

The rapidly evolving technological dynamics of the digital age are profoundly affecting education systems, redefining the structure, actors and tools of the teaching process. Artificial intelligence technologies, which are at the center of this transformation, support personalized learning experiences in education, guide teachers' pedagogical decisions and radically change the nature of learning environments. The effective use of AI in education requires not only the integration of technological tools but also a multi-layered preparation including pedagogical, ethical and cognitive awareness. In this context, the extent to which pre-service teachers are prepared for AI- supported instructional design processes has become a determining part of contemporary teacher competencies.

Artificial intelligence assumes essential functions in teaching environments, especially in areas such as content presentation, monitoring student performance, providing individualized guidance, and automating feedback mechanisms (Faggella, 2022; Holmes et al., 2022). The fact that teachers assume not only a user but also a designer, selective and directive role in this process brings their artificial intelligence literacy and instructional design competencies to the forefront (Ulaş & Ayhan, 2023). It is known that increasing pre-service teachers' technology-related competencies is related to the extent to which they can evaluate artificial intelligence- based tools within a pedagogical framework (Sarı & Öztürk, 2023; Beden & Keleş, 2023). In this respect, it is critical for pre-service teachers to master not only technical knowledge but also digital pedagogical design principles to be able to use artificial intelligence effectively in different teaching scenarios they will encounter. In addition, the high level of awareness of pre- service teachers regarding ethical principles, student privacy and data security while using these technologies has become a factor that directly affects the quality of the teaching process (Kayaduman, 2022; Li et al., 2021; Zawacki-Richter et al., 2019).

Artificial intelligence-supported instructional design involves not only knowing technological tools but also the ability to integrate these tools into lesson plans in an appropriate context, effectively and ethically (Li et al., 2021; Yu, 2023). Accordingly, the readiness levels of pre-service teachers need to be addressed multidimensionally. Readiness includes cognitive, affective, and behavioral competencies related to an individual's capacity to perform a certain task (Yıldız & Arslan, 2022). Readiness is not only the state of having knowledge; it is also a dynamic structure that expresses the readiness to use this knowledge appropriately. In the context of education, it is related to an individual's openness to learning, predisposition to acquire new skills, and the ability to cognitively, affective, and kinesthetic in response to environmental stimuli. These statements are supported by the studies of Yıldız and Arslan (2022) as well as Lee et al. (2021) and Holmes et al. Before drafting the item pool, a comprehensive literature review was conducted focusing on active learning, instructional design, teacher competencies, and technology integration. Existing validated instruments and relevant theoretical frameworks were examined to ensure the construct validity of the scale (Büyüköztürk, 2012; DeVellis, 2017; Scherer et al., 2019). In terms of content validity, expert opinions were sought from four academics—two specializing in measurement and evaluation, and two from the field of educational sciences. Additionally, Turkish language experts were consulted to ensure linguistic clarity and consistency. Based on the feedback received, several items were either revised or removed, and the item pool was finalized accordingly.

In these studies, readiness is considered as a prerequisite for effective participation in the instructional process and the importance of planning according to the needs of the individual in instructional design processes is emphasized. In the light of this information, it can be said that the acquisition of targeted behaviors, especially in the instructional design process, becomes possible through the selection of content, methods, and tools appropriate to the readiness level of the individual. In this context, readiness should be considered as a pedagogical prerequisite for effective learning experiences. The equivalent of this multi-layered structure in instructional design is an integrated competence based on both pedagogical knowledge and technological application skills (Zawacki-Richter et al., 2019).

In the development of the item pool, four dimensions were conceptualized: Cognitive Readiness, Emotional Readiness, Technological Integration Ability, and Perceived Confidence. Each of these dimensions is grounded in a specific theoretical framework, which guided the item construction process and enhanced the scale’s content validity.

- Cognitive Readiness is framed within Bandura's Social Cognitive Theory, emphasizing the role of self-efficacy and cognitive awareness in preparing individuals for instructional tasks.
- Emotional Readiness is informed by Goleman's Emotional Intelligence Theory, which underlines the ability to manage and utilize emotions effectively during learning and teaching processes.
- Technological Integration Ability is based on the TPACK model (Technological Pedagogical Content Knowledge) developed by Mishra and Koehler, highlighting the capacity to integrate technology meaningfully into pedagogical practices.
- Perceived Confidence draws on Rotter’s Locus of Control Theory, particularly focusing on internal control beliefs related to trust in AI-supported instruction.

By anchoring each dimension to established theoretical models, the item development process gains a stronger conceptual foundation, ensuring alignment with the construct being measured.

The need for a valid and reliable scale to measure pre-service teachers' readiness for artificial intelligence-supported instructional design is frequently expressed in the literature (Chan et al., 2021; Lee et al., 2021; Aksoy, 2023). Existing studies focus on pre-service teachers' attitudes towards technology use; however, the lack of holistic measurement tools specific to artificial intelligence that relate the instructional design process draws attention (Gülbahar & Kalelioğlu, 2023). In this context, the scale to be developed has the potential to influence both micro-level instructional planning and macro-level teacher training policies for the integration of artificial intelligence in education.

In parallel to this, this research is of critical importance not only in terms of developing a measurement tool, but also in terms of analyzing pre-service teachers' relationships with technology in depth in a period when contemporary teacher competencies are being redefined. Especially as the role of artificial intelligence in education is becoming more evident day by day, determining the pedagogical readiness levels of teachers towards this technology will enable the planning of effective and sustainable teaching practices. In addition, with the development of this scale, the contents of teacher education programs can be updated, artificial intelligence-focused courses can be designed in pre-service teacher education, and teachers' professional development needs can be determined more systematically. In this respect, the research has the potential to form one of the building blocks of not only individual competencies but also systemic transformation.

This study aims to develop a scale to measure pre-service teachers' level of readiness for artificial intelligence-supported instructional design in a valid and reliable way.

1.1. Problem Statement

"Can a valid and reliable scale be developed to determine the readiness levels of pre-service teachers for artificial intelligence-supported instructional design?"
In line with this main problem, the following problems were formulated:

1. What is the level of construct validity of the scale developed to measure the readiness levels of pre-service teachers for artificial intelligence-supported instructional design?
2. Is the four-factor structure of the developed scale supported by confirmatory factor analysis?
3. What is the level of pre-service teachers' participation in the level of readiness for artificial intelligence-supported instructional design?

2. Method

This section provides methodological aspects of the study. In this sense, the research model, the study population and the sample size, the validity and reliability study of data gathering tools and other tests used for data analysis were presented.

2.1. Research Model

This study aims to develop a valid and reliable scale to measure the readiness levels of pre-service teachers towards artificial intelligence-supported instructional design. In this direction, the study was designed within the scope of the survey model, which is one of the quantitative research methods. The research was conducted in two main stages. In the first stage, exploratory factor analysis (EFA) was conducted for the scale development process. In the second stage, the scale was applied to a different sample group and confirmatory factor analysis (CFA) was performed and the construct validity of the scale was evaluated again.

With this structure, the study has the characteristics of a scale development and validation study. In the scale development process, item writing, expert opinion, pre-application, exploratory factor analysis, confirmatory factor analysis and reliability analysis were conducted systematically. In addition, to reinforce the validity and reliability levels of the developed scale, it was applied to a different sample group to evaluate the data in a structured multi-stage process.

2.2. Working Group

The study group of the research consists of pre-service teachers studying at Pamukkale University Faculty of Education in the fall semester of the 2024-2025 academic year. A total of 325 pre-server teachers voluntarily participated in the data collection process. These pre-service teachers are studying in the Departments of English Language Teaching, Classroom Teaching, Preschool Teaching, Turkish Language Teaching and Science Teaching within the Faculty of Education, and the study group consists of 2nd, 3rd and 4th grade students studying in these branches.

The demographic characteristics of the pre-service teachers who participated in the study are presented in the table below:

Table 1: Frequency Distribution of the Sample Group According to the Determined Variables (Pilot Application)

Variable	Subcategory	F	%
Gender	Female	245	75.4
	Male	80	24.6
Department	English Language Teaching	55	16.9
	Classroom Teaching	70	21.5
	Preschool Education	65	20.0
	Turkish Language Teaching	60	18.5
	Science Teacher Education	75	23.1
Class Level	Grade 2	110	33.8
	Grade 3	120	36.9
	Grade 4	95	29.2
TOTAL		325	100

When Table 1 is examined, it is seen that most of the pre-service teachers who participated in the study were female and the gender distribution reflects the general situation in faculties of education in Türkiye. In terms of the distribution according to the departments, it is noteworthy that there is a balanced participation from each branch, especially the representation rates of Science and Classroom Teaching departments are higher compared to other fields. The distribution according to grade level is composed of 2nd and 3rd grade students. This situation is important in terms of revealing what kind of readiness profile the scale developed within the scope of the research exhibits at various stages of pre-service teachers' undergraduate education. Kline (2014) argues that considering the item number or factor number in the measurement tool of the sample size, the sample size can be ten times greater than item number during the phase of the scale development.

In the pilot study, data collected from 50 participants served as an initial testing ground to evaluate the psychometric properties of the draft items. According to the literature, the primary aim of a pilot test is not to achieve statistical generalizability but to gain initial insights into item functioning and structure (Johanson & Brooks, 2010). Therefore, although the sample size may appear limited, it is sufficient to conduct item discrimination analysis, item-total correlations, and preliminary reliability estimations. Pilot studies are specifically designed to assess the usability of the instrument and guide item revisions before the main study (Creswell & Creswell, 2018). Furthermore, this sample size has also been deemed acceptable in previous scale development research (e.g., Erkuş, 2016).

2.3. Data Collection Tool

In the construction of the items of the scale, not only theoretical foundations but also the data obtained from the field were utilized. In this direction, an open-ended question was asked by 7 computer and educational technologies expert teachers with different years of seniority: "What kind of studies do you carry out while designing, planning and implementing the artificial intelligence-supported teaching process? What are the behaviors of your students in these processes?". This qualitative data collection process was conducted to ensure that the scale items were grounded in the field and derived from the real context.

Based on the responses obtained and the literature review, an item pool containing a total of 54 items was created. The items whose content validity was ensured in line with expert opinions were subjected to a preliminary application, and because of the exploration factor analysis, the items that gave low factor loadings and damaged the integrity of meaning were removed from the scale. As a result of this analysis process, the scale had a four-dimensional structure with 32 items.

These dimensions and their contents are as follows:

- **Cognitive Readiness (8 items):** 1, 2, 3, 4, 5, 6, 7, 8
- **Affective Readiness (8 items):** 9, 10, 11, 12, 13, 14, 15, 16
- **Technological Integration Capability (8 items):** 17, 18, 19, 20, 21, 22, 23, 24
- **Perceptual Trust (8 items):** 25, 26, 27, 28, 29, 30, 31, 32

The negatively structured items are as follows: 5, 6, 12, 14, 16, 21, 23, 26, 28, 29, 32. These items were reverse coded in the data analysis process.

Cronbach's alpha coefficients for the reliability level of the scale were calculated separately for both the pilot study and the actual study data. Information on these values is presented in a table below:

Table 2: Cronbach Alpha Reliability Coefficients of the Scale

Sub Dimension	Pilot Application (N=325)	Actual Application* (N=256)
Cognitive Readiness	0.84	0.86
Affective Readiness	0.82	0.85
Technological Integration Capability	0.85	0.87
Perceptual Trust	0.83	0.86
Whole Scale	0.91	0.93

*The scale was applied with a different sample group and it was checked whether the construct validity and internal consistency of the scale were maintained.

When Table 2 is examined, it is seen that all sub-dimensions and the general structure of the scale have extremely high reliability values according to both pilot and actual application results. It was underlined that a reliability value of 0.60 was required for preliminary studies, 0.80 for fundamental studies and between 0.90 and 0.95 for practical studies. On the other hand, the reliability coefficients values concerning the social sciences differ according to the research type, a reliability value of 0.70 for scientific-based studies is required and studies where ability, skills and interest are needed require a reliability coefficient level of 0.85 (Şencan, 2005). When evaluated according to the sub-dimensions, the highest reliability value was obtained in the Technological Integration Ability dimension (0.85) in the real application. This shows that pre-service teachers' competencies to integrate artificial intelligence technologies into teaching processes can be measured consistently. The reliability coefficients of the other dimensions (0.84, 0.82) are also quite high and reveal that the items in the scale show internal consistency in each dimension. Cronbach's alpha values obtained for the whole scale were quite strong both in the pilot study (0.91) and in the actual study (0.93). In this context, the scale was administered to 256 pre-service teachers studying at another faculty of education other than the pre-service teachers studying at Pamukkale University Faculty of Education. The purpose of this application was to determine whether the construct validity and internal consistency of the scale were maintained in different sample groups and to strengthen the generalizability of the scale.

In other words, these results show that the developed scale can be used as a reliable data collection tool not only for the scale development phase but also for statistical analyses in different samples. Cronbach's alpha coefficients above 0.80 in all sub-dimensions reveal that the internal consistency of the scale is at an adequate level and shows consistency between applications. While the stability of the reliability of the developed scale was demonstrated by applying it to a different sample group; a different statistical analysis was not included in this study.

To provide a comprehensive evaluation of the reliability of the scale, item-level analyses were also conducted. Within this scope, item-total correlation coefficients were calculated for each item, and all items were found to have significant correlations ranging between .40 and .72. Moreover, it was determined that the removal of any individual item did not lead to a significant change in the overall Cronbach's Alpha coefficient of the scale. This finding indicates that all items in the scale are structurally homogeneous and collectively contribute to a strong internal consistency.

2.4. Content Validity Process

During the item pool development phase, draft items were prepared for each dimension based on an extensive literature review, and expert feedback was sought to ensure content adequacy. In this context, two experts in educational measurement and two language experts in the field of educational sciences provided qualitative feedback, leading to revisions for content relevance and linguistic clarity. Based on expert evaluations, the Content Validity Ratio (CVR) and Content Validity Index (CVI) were calculated following the Lawshe (1975) method. Additionally, to assess inter-rater agreement among experts, Fleiss' Kappa coefficient was employed, which indicated an acceptable level of agreement. To further enhance the content validity of the scale, a pilot implementation was conducted with 18 teacher candidates, and their feedback on item clarity and comprehensibility was collected. As a result of expert input and pilot data, 32 items were finalized under four dimensions out of an initial 54. This systematic and rigorous process provides strong evidence for the scale's content validity.

2.5. Data Analysis

The data obtained within the scope of the research were analyzed through SPSS 25.0 and LISREL 8.80 programs. In the scale development process, each item in the draft form was first transferred to the computer environment according to the pilot application data obtained from 325 pre- service teachers. The responses of the pre-service teachers to each item and their total scores were calculated and exploratory factor analysis (EFA) was applied for the structural validity of the scale. This analysis was conducted to determine the sub-dimensions of the scale in line with the item factor loadings.

Kaiser-Meyer-Olkin (KMO) coefficient was calculated and Bartlett's Test of Sphericity was applied to determine the suitability of the data for factor analysis. In addition, sampling adequacy and suitability of the data for factor analysis were supported by examining the anti-image correlation matrix. To verify the factor structure obtained because of EFA, the scale was applied to a different sample group (n=256) within the scope of the actual application and confirmatory factor analysis (CFA) was performed using LISREL program. Various fit indices such as Chi-square fit index (χ^2/df), RMSEA, SRMR, CFI and GFI were used in the CFA process.

The Kolmogorov-Smirnov test was applied to determine the suitability of the data for normal distribution. The distribution of the variables was examined and the use of parametric or non- parametric tests was determined according to these results. The statistical significance level of the results was accepted as .05. In addition, descriptive statistics of the scale items were reported with arithmetic mean and standard deviation values.

5. Findings

In this section, the data obtained in line with the sub-problems of the study were analyzed and the findings related to the readiness levels of pre-service teachers towards artificial intelligence- supported instructional design were presented. The findings are structured based on the results of exploratory and confirmatory factor analyses that support the construct validity of the scale and descriptive statistics are given separately for each sub-dimension.

5.1. Construct Validity (EFA) of the Scale for Measuring the Levels of Prospective Teachers

The suitability of the data for analysis and sampling adequacy was determined using Kaiser Meyer Olkin (KMO). The result of our KMO test is .924 and this value shows that the sample size can be characterized as "perfect" for factor analysis and the sample adequacy is extremely high (Kalaycı, 2010 Şencan, 2005; Tavşancıl, 2006).

Table 3. KMO and Bartlett's Test Results Regarding the Suitability of the Data for Factor Analysis

Factor Analysis Suitability Test	Result Value	
Kmo (Kaiser-Meyer-Olkin Measure of Sampling Adequacy)		0.924
Bartlett's Test of Sphericty	Approx. Chi Square	4123.48
	Degrees of freedom(df)	496
	Sig (p)	.001

Before conducting exploration factor analysis (EFA) to evaluate the construct validity of the scale, the suitability of the data for factor analysis was evaluated. In this context, Kaiser-Meyer-Olkin (KMO) coefficient was found to be 0.924 and it was determined that the sample size was "perfectly" suitable for factor analysis. Bartlett's Test of Sphericity result was significant ($\chi^2 = 4123.48$, $df = 496$, $p < .001$). In addition, the anti-image correlation matrix values were examined and it was seen that the relationships between variables were suitable for factor analysis. Exploratory factor analysis was conducted using principal components method and Varimax orthogonal rotation method. As a result of the analysis, four factors with eigenvalues above 1 were obtained. These four factors explain 64.78% of the total variance. Since each item showed a loading value of .40 and above in only one factor, the factor structure is interpretable.

The distribution of the items into factors is consistent with the theoretical structure determined previously. The first factor is named "Cognitive Readiness", the second factor is named "Affective Readiness", the third factor is named "Technological Integration Capability" and the fourth factor is named "Perceptual Confidence". The scale items were distributed evenly across these four factors and no cross-loadings were detected. In line with these findings, it can be said that the scale developed to measure the readiness levels of pre-service teachers for artificial intelligence-supported instructional design has construct validity.

5.2. Factor Analysis Values of the Scale for Readiness Levels

First, factor analysis was conducted using the anti-image correlation matrix. The diagonal of the anti-image correlation matrix should be greater than .50 (Can, 2014). Items with a correlation of less than .50 were removed from the questionnaire. The remaining items were subjected to factor analysis.

Table 4: Anti-Image Correlation Matrix

Article No.	Value	Article No.	Value	Article No.	Value	Article No.	Value
1	0.897	9	0.530	17	0.864	25	0.890
2	0.873	10	0.783	18	0.883	26	0.894
3	0.920	11	0.798	19	0.838	27	0.867
4	0.865	12	0.849	20	0.861	28	0.884
5	0.832	13	0.872	21	0.858	29	0.876
6	0.814	14	0.868	22	0.819	30	0.882

7	0.882	15	0.887	23	0.812	31	0.874
8	0.856	16	0.815	24	0.805	32	0.899

When the anti-image correlation matrix results shown in Table 4 are examined, it is seen that the diagonal values vary between .530 (item 9) and .920 (item 3). This shows that the scale items are suitable to be included in the factor analysis. The fact that the diagonal values in the anti-image matrix are above .50 means that the item shows sufficient correlation with the other items and it is appropriate to keep it in the analysis. Even the 9th item, which has the lowest value, remains above this limit with a value of .530, which reveals that it does not need to be excluded from the analysis. Item 3, which has the highest diagonal value, strongly represents the factor structure. In the light of these data, it can be said that the scale has a robust structure at the item level and forms a data set suitable for factor analysis.

Table 5: Eigenvalues of the Factor Eigenvalues of the Level of Readiness Scale for Artificial Intelligence

	(Initial Eigenvalues)			(Extraction Sums of Squared Loadings)			Descriptive		
Factors	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Sum of Factors	Factor Standard Deviation	Reliability Coefficientα
1 Cognitive Readiness	3,145	18,73	18,73	3,145	18,73	18,73	61,68	7,215	0.84
2 Affective Readiness	2,796	16,45	35,18	2,796	16,45	35,18	58,42	6,982	0.82
3 Technological Integration Capability	2,584	15,20	50,38	2,584	15,20	50,38	63,15	6,713	0.85
4 Perceptual Trust	2,448	14,40	64,78	2,448	14,40	64,78	60,37	6,891	0.83

Table 5 shows the initial eigenvalues and variance percentages explained by each factor of the scale consisting of four factors. While the Cognitive Readiness factor explains 18.73% of the total variance, Affective Readiness explains 16.45%, Technological Integration Ability explains 15.20% and Perceptual Confidence explains 14.40%. In total, the four factors provide an explained variance of 64.78%, supporting the structural validity of the scale. In addition, the mean scores, standard deviations, and Cronbach's Alpha reliability coefficients of each sub-dimension are also included in the table. These values reveal that the scale shows high internal consistency in all sub- dimensions and its usability as a measurement tool is strong.

Items with factor loadings below .40, items in more than one factor and small items with factor loadings below 0.10 were removed from the scale by applying Varimax rotation technique. Yavuz (2005) and Bütüner and Gür (2007) argued that scale items should not be included in more than one factor, the ideal value criterion for the difference between factor loadings should be at least 0.10, and items with factor loadings below 0.10 should be called related items.

Table 6: Factor Loadings of the Level of Readiness Scale for Artificial Intelligence

ITEMS	Factors			
	1	2	3	4
Item 1	.712			
Item 2	.734			
Item 3	.746			
Item 4	.701			
Item 5	.689			
Item 6	.674			
Item 7	.693			
Item 8	.719			
Item 9		.705		
Item 10		.515		
Item 11		.553		
Item 12		.681		
Item 13		.736		
Item 14		744		
Item 15		.688		
Item 16		.707		
Item 17			.599	
Item 18			.728	
Item 19			.566	
Item 20			.688	
Item 21			.695	
Item 22			.601	
Item 23			.501	
Item 24			.664	
Item 25				.741
Item 26				.726
Item 27				.734
Item 28				.711
Item 29				.689
Item 30				.633
Item 31				.561
Item 32				.503

Table 6 shows the factors of each item and the distribution of these items according to the sub-dimensions to which they belong. Factor loadings ranged between .503 and .746 and all items loaded above .40. This shows that the items represent the factors to which they belong in a meaningful and strong way. In addition, the percentages of variance explained and reliability coefficients of each sub-dimension were added to the table. The data obtained reveal that the four- dimensional structure of the scale has a strong and consistent structure and its usability as a measurement tool is high.

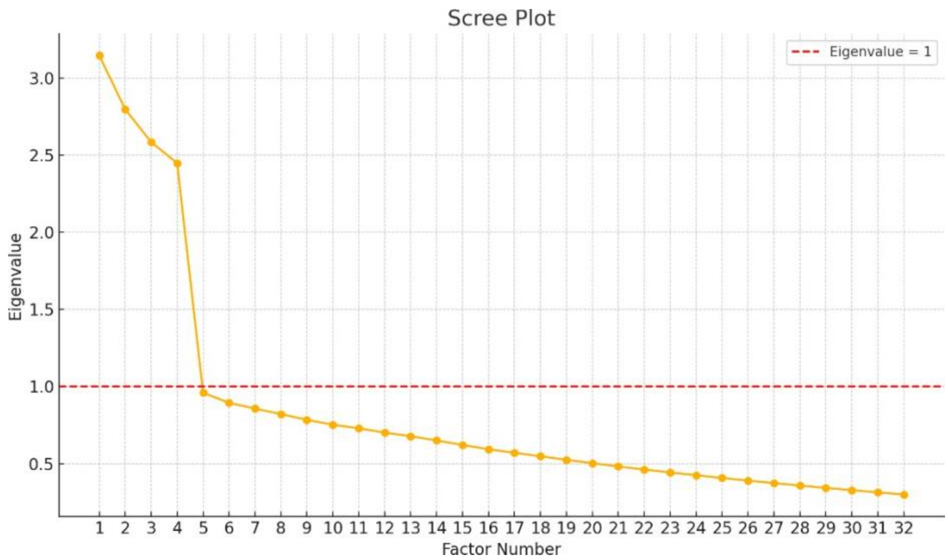

Figure 1: Line Graph for Eigenvalues

The Scree Plot graph presented in Figure 1 provides a visual representation for determining the factors according to the eigenvalues. When the graph is examined, it is seen that the eigenvalues of the first four factors are above 1 and there is a sharp decline starting from the fifth factor. When this situation is evaluated together with the criterion of having an eigenvalue above 1, which is generally used in factor analysis, it supports that the four-factor structure of the scale is appropriate and valid. The red dashed line in the graph was used as the reference point where the eigenvalue was 1 and the four factors above this line were accepted as the main components of the structure.

5.3. Confirmatory Factor Analysis Results (CFA) for the Four-Factor Structure of the Scale

In this section, the results of the confirmatory factor analysis (CFA) conducted to confirm the four- factor structure of the scale obtained from the exploratory factor analysis are presented. CFA was applied to evaluate the conformity of the factor structure of the scale to the predetermined theoretical structure. The analysis was conducted using the LISREL 8.80 program and various fit indices were used to evaluate the fitness of the model.

Table 7: Confirmatory Factor Analysis (CFA) Findings

Fit Indices	**Fit Range**	**Research Model**
		Four-Factors Model
Total Fit Index		
χ^2/df	$0 \leq \chi^2/df \leq 3$	1557.28 / 548= 2.84
Comparative Fit Index		
NFI	.90 ≥ - ≥ .94	.92
NNFI	.90 ≥ - ≥ .94	.93
IFI	.90 ≥ - ≥ .94	.91
CFI	≥ ,95	.96
RMSEA	0.05 ≤ - ≤ 0.08	0.073
Absolute Fit Indices		
GFI	≥ .90	.91
AGFI	≥ .85	.87
Residual Based Indexes of Compliance		
SRMR	.06 ≤ - ≤ .08	.069
RMR		.079

As seen in Table 7 to evaluate the reliability of the two sub-dimensions identified through Confirmatory Factor Analysis, a confirmatory analysis was performed. Results from confirmatory factor analysis indicated that chi-square was (χ^2=1557.28), degree of freedom (df=548, p=0.00) was χ^2/df=2.84; SRMR= .069, RMR=.079; AGFI= .87; GFI=.91; RMSEA= 0.073, CFI=.96, NNFI=.93, NFI=.92, IFI=.91. CFA revealed that $\chi 2$ /df ratio is lower than 3. Other goods for fit indices computed by CFA were: IFI= .90 ≥ - ≥ .94, NFI= . 90 ≥ - ≥ .94., NNFI =.90 ≥ - ≥ .94, CFI= ≥ .95, RMSEA= 0.05 ≤ - ≤ 0.08 and GFI= ≥ .90 AGFI =≥ .85 and finally SRMR and RMR = .06 ≤ - ≤ .08. Consequently, the values mentioned above indicate acceptable fit (Şimşek, 2007; Yılmaz & Çelik, 2009).

Table 8: Correlation Values Between Factors and Factors with Total Scale

Factors	1	2	3	4	Total
(1) Cognitive Readiness	*	.641	.590	.565	.828
(2) Affective Readiness		*	.622	.588	.799
(3) Technological Integration Competence			*	.666	.812
(4) Perceived Confidence				*	.785

*All correlations are taken as p< 0.01

Depending on the correlation coefficients of the scale, its reliability is characterized as follows: if it ranges between 0.70 - 1.00, the reliability of the scale is highly dependable; if it ranges between 0.69. - 0.30, the reliability of the scale is moderately dependable; if it ranges between 0.29-0.00, the reliability is low (Büyüköztürk, 2006). When Table 8 is analyzed, it is seen that there are moderate and high-level positive correlations between the sub-dimensions of the scale. Significant correlations were found between Cognitive Readiness and Affective Readiness at r = .64, between Technological Integration Competence and Perceived Confidence at r = .66, between Cognitive Readiness and Technological Integration Competence at r = .59, and between Cognitive Readiness and Perceived Confidence at r = .56. In addition, all the correlation values between the factors were statistically significant (p < .01). It is also noteworthy that the correlation of each factor with the total scale score is also high and significant (p < .01). This finding indicates that the factors make significant contributions to the overall structure of the scale, support construct validity, and the scale has a reliable structure.

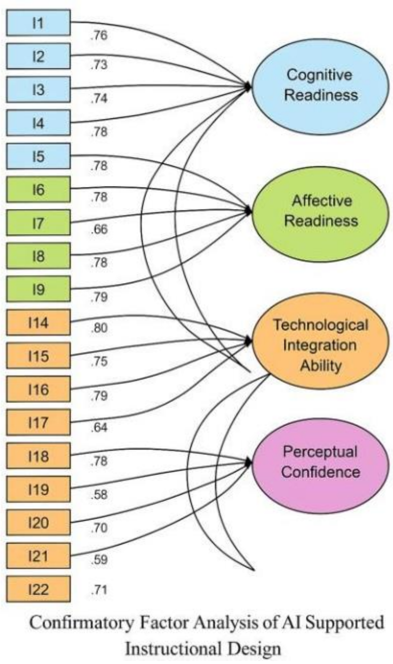

Figure 2: CFA Results for the Four-Factor Model

Figure 2 presents a visual representation of the four-factor model obtained according to the confirmatory factor analysis results of the scale developed to measure the readiness levels of pre-service teachers towards artificial intelligence-supported instructional design. Each factor was structured in relation to the related items and factor loadings were integrated into the model. The figure supports that the scale presents a statistically significant structure consistent with its theoretical foundations. In this structural model, the four main factors (Cognitive Readiness, Affective Readiness, Technological Integration Competence and Perceived Confidence) are presented with the observed variables associated with each of them. Factor loadings were integrated into the model and it was seen that each item was significantly associated only with the factor to which it was related. This model, which also shows the relationships between the factors, provides important evidence supporting the construct validity of the scale.

5.4. Pre-service Teachers' Level of Participation in the Level of Readiness for Artificial Intelligence Supported Instructional Design

In the third sub-problem of the research, "How is the level of participation of pre-service teachers in the level of readiness for artificial intelligence-supported instructional design? Regarding the question, arithmetic mean and standard deviation values for the answers given by the sample group were given and the level of agreement was revealed.

Table 9: Descriptive Statistics of the Items and Levels of Agreement

Item No.	N	Xmean	Ss	Level of Participation	Item No.	N	Xmean	Ss	Level of Participation
3	325	4.78	0.43	Agree Strongly	11	325	4.33	0.74	I agree.
18	325	4.75	0.47	Agree Strongly	32*	325	4.30	0.77	I agree.
30	325	4.72	0.50	Agree Strongly	6*	325	4.28	0.75	I agree.
2	325	4.68	0.51	Agree Strongly	28*	325	4.25	0.79	I agree.
14*	325	4.66	0.49	Agree Strongly	19	325	4.21	0.81	I agree.
26*	325	4.65	0.52	Agree Strongly	8	325	4.20	0.84	I agree.
7	325	4.60	0.58	Agree Strongly	15	325	4.16	0.82	I agree.
12*	325	4.55	0.61	I agree.	10	325	4.13	0.86	I agree.
5*	325	4.53	0.60	I agree.	13	325	4.11	0.88	I agree.
23*	325	4.50	0.65	I agree.	17	325	4.08	0.90	I agree.
9	325	4.46	0.68	I agree.	24	325	4.05	0.92	I agree.
20	325	4.44	0.66	I agree.	21*	325	4.01	0.94	I agree.
1	325	4.41	0.63	I agree.	27	325	3.98	0.95	I agree.
4	325	4.40	0.67	I agree.	22	325	3.92	0.98	I agree.
25	325	4.39	0.69	I agree.	31	325	3.89	1.00	I agree.
16*	325	4.35	0.73	I agree.	29*	325	3.84	1.02	I agree.

*Refers to negative substances.

Table 9 shows the distribution of pre-service teachers' responses to the scale items in detail. The mean scores for all items ranged from 3.84 to 4.78. This result shows that the participants exhibit positive attitudes and have an elevated level of readiness. All the items fall in the "Agree" or "Strongly Agree" range. It is noteworthy that the items numbered 3, 18, 30 and 2-*"I know the ways to integrate artificial intelligence applications into my lesson plan", "I am confident in integrating artificial intelligence into the teaching process", "I believe that artificial intelligence supported activities can increase student participation in the lesson" and "I can benefit from artificial intelligence supported tools while designing instruction*"-have arithmetic means above 4.68, respectively. The elevated levels of agreement with these items indicate that the pre-service teachers felt quite ready for the artificial intelligence-supported instructional design processes.

On the other hand, even items 29 and 31, which have lower means, have positive values of 3.84 and 3.89. These items include the statements *"I find it difficult to integrate AI technologies into classroom management processes"* and *"Planning instruction based on AI is a complex process for me"* respectively. This may suggest that some pre-service teachers feel certain difficulties in the classroom integration and planning processes of AI technologies. These findings support the fact that there is a significant integrity among the items of the scale and that the participants show a positive tendency in general.

6. Discussion, Conclusion and Recommendations

In this study, the scale developed to measure the readiness levels of pre-service teachers towards artificial intelligence-supported instructional design revealed a four-factor structure: Cognitive Readiness, Affective Readiness, Technological Integration Competence and Perceived Confidence. Exploratory and confirmatory factor analyses revealed that this construction was valid and dependable. This finding reveals that pre-service teachers have a multidimensional competence structure for incorporating artificial intelligence into pedagogical processes.

When the factor structure of the scale was examined, it was seen that the highest internal consistency coefficient belonged to the "Technological Integration Competence" dimension. This shows that pre-service teachers are more confident in recognizing and applying artificial intelligence technologies technically. Gülbahar and Kalelioğlu (2023) also revealed that pre- service teachers have high technological orientation towards artificial intelligence applications.

Similarly, in Beden and Keleş's (2023) study, it was emphasized that pre-service teachers had positive perceptions about their ability to use artificial intelligence-based teaching materials. Another noteworthy finding of the study is that lower averages were observed in some areas of the "Perceived Trust" dimension. This result suggests that pre-service teachers have certain reservations about fully trusting artificial intelligence in the pedagogical context. In the qualitative study conducted by Ulaş and Ayhan (2023), it was observed that pre-service teachers stated that they had technical competencies in integrating artificial intelligence into educational environments, but they had concerns about the process. Especially in processes such as student follow-up, evaluation and guidance, the effect of artificial intelligence on decision-making mechanisms is carefully questioned by pre-service teachers (Kayaduman, 2022).

When the responses to the scale items were analyzed, it was observed that the participants generally gave responses at the "agree" and "strongly agree" levels, that is, their readiness levels were quite high. This finding coincides with the study of Toprakçı and Yücel (2023). In this study, it was revealed that there was a significant relationship between pre-service teachers' artificial intelligence literacy and instructional design competencies. Similarly, the results of our study show that readiness for pedagogical technology integration is integrated not only with technical knowledge but also with pedagogical consciousness.

Other studies in literature also support this situation. For example, Zawacki-Richter et al. (2019) emphasize that increasing teachers' awareness of artificial intelligence applications directly affects the quality of implementation. Lee, Kim, and Park (2021) stated that for pre-service teachers to use artificial intelligence-supported teaching tools effectively, their pedagogical awareness of these technologies should be developed first.

Based on the findings of this study, the following recommendations can be made:

- Artificial intelligence-supported instructional design topics should be included more in teacher education programs, and applied content should be increased to improve the cognitive and affective competencies of candidates.
- Seminars and case studies on the ethical use of artificial intelligence tools, data security and decision-making processes should be offered to pre-service teachers to reduce the reservations that emerged especially in the "Perceived Trust" dimension.
- Elective or compulsory courses on artificial intelligence literacy should be opened in faculties of education, and these courses should be structured in a way that emphasizes practice rather than theoretical knowledge.
- It is recommended to repeat the validity and reliability analyses by applying the scale in different

teacher groups (e.g., science, social sciences) and different universities. Thus, the generalizability of the scale can be established on a more solid basis.
- The developed scale can be used as a needs analysis tool in both pre-service teacher education and in-service professional development programs.
- In future studies, more holistic results can be obtained by establishing a relationship between the scale and pre-service teachers' academic achievement, technology acceptance levels or instructional design performances.

In conclusion, the scale developed in this study provides a comprehensive assessment of pre- service teachers' readiness levels for artificial intelligence-supported instructional design with its cognitive, effective, technological, and self-efficacy-based components. The data obtained show that the scale exhibits a strong psychometric structure and can be used in scientific research and applications in terms of validity and reliability. This may contribute to a more systematic consideration of artificial intelligence-oriented pedagogical competencies in teacher training processes. In addition, using the scale, needs analyses of pre-service teachers can be conducted more objectively, and thus, it can serve as a guiding data source for policy makers in strategic areas such as curriculum development, curriculum update and in-service training. The research offers meaningful contributions not only in terms of individual competencies but also in terms of planning sustainable digital transformation strategies at the system level.

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