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Validation and Psychometric Evaluation of the Artificial Intelligence Literacy Scale in Second Language Writing: A Study Among Iranian Student Teachers

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ABSTRACT

Objective: This study aimed to validate and examine the psychometric properties of the Persian version of the Artificial Intelligence Literacy Scale in Second Language Writing among Iranian student teachers.

Method: The research employed a descriptive-survey design and falls within the category of instrument development (psychometric) studies. The statistical population consisted of all student teachers at Farhangian University in the academic year 2025–2026, from whom 828 participants (485 females and 343 males) were selected through convenience sampling. To precisely examine the psychometric properties and prevent overfitting, the total sample was randomly divided into two independent subsamples of 414 participants each. The first subsample was used for exploratory factor analysis (EFA), and the second subsample was used for confirmatory factor analysis (CFA). Reliability was assessed using Cronbach's alpha and composite reliability, and criterion-related validity was examined through correlation with the construct of attitude toward the use of artificial intelligence in second language learning.

Results: Exploratory factor analysis on the first subsample extracted a four-factor structure (Understanding, Usage, Evaluation, and Ethics) that explained 56.15% of the total variance. Confirmatory factor analysis on the second subsample confirmed the desirable fit of the extracted model and the hierarchical structure of the scale. The scale demonstrated high reliability (Cronbach's alpha = 0.93; composite reliability > 0.80). Criterion-related validity was supported by a positive and significant correlation (r = 0.73) with the attitude construct. The mean artificial intelligence literacy of the students was above average, with the Ethics component obtaining the highest score and the Evaluation component the lowest.

Conclusions: The findings indicate that the Persian version of the Artificial Intelligence Literacy Scale in Second Language Writing is a valid and reliable instrument for assessing AI literacy in L2 writing within the Iranian higher education context. It can serve as a basis for designing educational courses focused on critical thinking and the ethical use of modern technologies.

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1. Introduction

In recent decades, the integration of emerging technologies into educational systems has confronted teaching and learning processes with fundamental changes; however, no transformation has influenced the foundations of education with such speed and scale as the recent advancements in the field of artificial intelligence (Torrisi-Steele, 2025; Yadav, 2025). The integration of artificial intelligence into educational spaces and its combination with learning models fundamentally transforms teaching and learning approaches (Liu et al., 2024; Yilmaz et al., 2023). Generative artificial intelligence, particularly large language models, is considered a turning point in the history of modern education. In this context, the learning of various language skills, and especially the skill of second language writing, due to its complex, cognitive, and productive nature, has been most affected by this technology (Alqurashi, 2025). Furthermore, experts believe that second language learning, owing to its interactive nature and the urgent need for diverse linguistic input, has been more influenced by these innovations than other domains (Suchy, 2024). In fact, distinctive features such as the necessity of receiving immediate corrective feedback and the need for access to rich linguistic resources appropriate to the learner's level have caused generative artificial intelligence to become a key tool for personalizing the learning process.

These systems, by adapting based on the needs and individual characteristics of learners, create a form of alignment between educational content and their personal requirements (Asher & Zweigenbaum, 2020; Jiang, 2022). Those interested in second language learning interact with artificial intelligence tools not only as assistants for improving written output, but also as sources of linguistic input, providers of feedback, and even learning partners to support language development in multiple dimensions (Barrot, 2023). Advanced systems such as conversational robots, using natural language processing technology, are able to detect linguistic errors with high accuracy and provide immediate corrective suggestions (Bicknell et al., 2023; Liu & Ma, 2023).

Artificial intelligence in this domain has appeared not only as an auxiliary tool for grammatical corrections, but also as an intelligent collaborator in the process of ideation, content organization, and linguistic enrichment, and has challenged the traditional boundaries between the human writer and the technological tool (Suchy, 2024; Lucas et al., 2024; Zhu, 2025). These tools, with the ability to generate coherent texts, respond to complex commands, and provide instantaneous feedback, improve pre-writing strategies and the revision process (Weidlich et al., 2025) and have transformed the traditional roles of the teacher and the learner (Hutson, 2024). Studies show a significant statistical improvement in the writing quality

(content, organization, and structure) of students who use artificial intelligence tools (Arif & Naeem, 2025).

Research in the field of language education assisted by artificial intelligence, especially second language writing assisted by artificial intelligence, has recently expanded considerably (Barrot, 2023; Kang & Yi, 2023). This growing body of literature is mainly focused on the effects of artificial intelligence tools on second language writing from the perspective of practical applications or the perceptions of teachers and students. Alongside the dual effects of artificial intelligence tools on second language writing, namely opportunities and challenges (Warschauer et al., 2023; Yuan et al., 2024), most related studies examine the effects of these tools in relation to writing assessment, learning improvement, and psychological impacts. For example, Mehrani-Rad (2025) in a study showed that the use of a dedicated artificial intelligence-based language education platform simultaneously led to a significant reduction in anxiety, an increase in learning enjoyment, and an improvement in motivation among language learners. Likewise, Molavi Nafchi, Maddahian, and Hosseini (2025) in a qualitative study showed that English literature students consider generative artificial intelligence as a complementary tool (and not a substitute) that can be effective in increasing speed, expanding creativity, and facilitating learning. Nevertheless, students' widespread access to these technologies has raised serious concerns regarding academic integrity, the authenticity of writing, and the possibility of the decline of critical thinking (Asim et al., 2024; Yan, 2023; Barrot, 2023).

Therefore, the redefinition of plagiarism and originality in academic writing is necessary (Kotsis, 2024), because content generated by artificial intelligence blurs the boundaries of authorship (Hutson, 2024). On the other hand, reliance on artificial intelligence for completing writing assignments may reduce students' engagement with the writing process and lead to a superficial understanding of content production (Medina et al., 2024). These challenges indicate that merely equipping educational environments with technology is not sufficient; rather, learners need core competencies in the domain of artificial intelligence literacy that go beyond simple technical skills and include the ability to critically analyze algorithmic outputs, manage data biases, and address ethical challenges in interacting with these technologies. In response to this urgent need, the construct of artificial intelligence literacy has been raised since 2014 as a novel necessity and a vital skill for the twenty-first century (Ng et al., 2021). Artificial intelligence literacy goes beyond basic technical skills or the ability to work with a specific software (Simms, 2025). This construct refers to a set of competencies that enable the individual to interact with artificial intelligence technologies in a critical (McPhee & Jerowsky, 2025), ethical (Nyakora & Monda, 2025), and effective (Asrifan et al., 2024) manner.

In fact, possessing mere technical skill for machine-generated text production, without possessing artificial intelligence literacy, can lead to destructive dependence and unreflective use of technology. Some researchers go beyond the above and believe that artificial intelligence literacy also includes socio-cultural awareness (Tofiq & Latif, 2025); that is, they consider it essential to recognize socio-economic gaps in access to artificial intelligence and their consequences for equitable participation in artificial intelligence discourses. Artificial intelligence literacy enables learners to methodically evaluate the credibility of resources generated by artificial intelligence, identify hidden biases in the training data of algorithms, and use these tools responsibly in academic writing by understanding the ethical implications related to privacy and intellectual property (Choi et al., 2025). Therefore, artificial intelligence literacy has emerged as a vital set of competencies that enables individuals, including teachers and students, to work effectively and safely with artificial intelligence tools and evaluate them (Knoth et al., 2024; Ng et al., 2021).

Despite the increasing importance of this concept, research in the domain of artificial intelligence literacy in second language writing is still nascent (Ou et al., 2024). Most existing studies have focused on general artificial intelligence literacy and often utilize general conceptual frameworks, while the competencies required for interacting with artificial intelligence can vary widely across different domains and disciplines and reflect the distinct knowledge and skills required in each domain (Ou et al., 2024). Excessive reliance and uncritical interaction with artificial intelligence tools can hinder linguistic growth and learner autonomy. Hence, general artificial intelligence literacy frameworks are incapable of explaining the nuances of writing; a matter that emphasizes the necessity of utilizing domain-oriented frameworks to correctly explain how these tools are understood, applied, and evaluated in the language learning process (Knoth et al., 2024; Laupichler et al., 2022; Ng et al., 2024).

In the educational context of Iran, teacher training is the responsibility of Farhangian University, which, as the main custodian, pursues the task of providing specialized human resources for the Ministry of Education. With the increasing expansion of artificial intelligence tools and the emphasis of upstream documents and macro-level transformational documents of the country (such as the Fundamental Transformation Document of Education and the Comprehensive Scientific Map of the Country) on the necessity of digital transformation and the development of educational equity through technology, Iran's higher education system, especially in the domain of teacher training, has begun the process of integrating smart technologies into curricula. Despite macro-level policies for integrating technology into the national curriculum, the use of artificial intelligence in second language education classrooms still faces structural and skill-related challenges. Student teachers in this system play a dual

role; on the one hand, they must enhance their own writing skills, and on the other hand, they must prepare to guide future generations in educational environments integrated with artificial intelligence. Therefore, understanding the level of artificial intelligence literacy in this specific community is not only an educational need, but a strategic necessity for the future of education and training in Iran.

Despite the increasing importance of artificial intelligence literacy, research in this domain is still nascent. The existing research gap can be explained at three levels: First, most studies have focused on general artificial intelligence literacy, while measuring writing competencies requires a specialized and domain-oriented approach. Second, despite the development of theoretical tools, the lack of valid psychometric scales for operationalizing and precisely evaluating this construct is clearly felt (Xu et al., 2025). Third and most importantly, a review of the research background shows that, up to the time of writing this study, no localized instrument with confirmed psychometric properties is available to researchers for specifically measuring this construct in the Iranian educational context, especially among the community of student teachers. Since student teachers interact with transformative technologies, the lack of access to an instrument for evaluating their level of readiness constitutes a serious barrier to the systematic monitoring of learning and educational policymaking. Therefore, the present study aims to fill these gaps by validating the L2W-SAILS scale. To respond to this need, the present study has been conducted with the aim of validating and localizing the Persian version of the Students' Artificial Intelligence Literacy Scale in Second Language Writing (L2W-SAILS). The selection of this scale as the main instrument is based on the comprehensiveness of its four-dimensional conceptual framework, which was designed by Xu et al. (2025) for the specific domain of second language writing. This framework is itself the result of the synthesis and revision of foundational models of artificial intelligence literacy; such that the initial model of Ng et al. (2021) identified the four pillars of "knowledge and understanding," "use and application," "evaluation and creation," and "ethics," and then Warschauer et al. (2023) operationalized these dimensions in the context of second language writing. Since the present research is a validation study, in order to maintain structural integrity and content validity of the reference instrument, all four dimensions explained in the original scale were simultaneously assessed in the form of independent subscales under a single multidimensional instrument; these four dimensions are: (1) Understanding: basic knowledge and attitude; (2) Usage: practical skill and behavior; (3) Evaluation: critical judgment and selection; and (4) Ethics: ethical and security considerations. The four dimensions of the present scale have complete alignment with the comprehensive framework of Knoth et al. (2024); such that the "Understanding" dimension corresponds to the knowledge/cognition competency, the "Usage"

dimension to skill/behavior, the "Evaluation" dimension to attitude/value, and the "Ethics" dimension to the ethics component in that framework. Therefore, this scale, due to possessing solid theoretical foundations, specific focus on the domain of second language writing, and the potential to fill the gap in indigenous assessment tools, was selected as an optimal instrument for validation among Iranian student teachers. Given the aforementioned necessities, the present study seeks to answer the following questions: (1) What is the exploratory and confirmatory factor structure of the Persian version of the artificial intelligence literacy scale in second language writing among Iranian student teachers? (2) To what extent does the Persian version of the artificial intelligence literacy scale in second language writing possess validity and reliability? (3) How is the status of artificial intelligence literacy of Iranian student teachers in the domain of second language writing evaluated?

2. Methodology

The present research, from the perspective of purpose, falls within the category of methodological studies, and in terms of nature and method, is considered an instrument development (psychometric) study. The main aim of this study was to translate and validate the Artificial Intelligence Literacy Scale in Second Language Writing (L2W-SAILS) and to examine its psychometric properties among student teachers of Farhangian University in Iran. This research was conducted with a focus on examining the factor structure (exploratory and confirmatory), reliability, and construct validity of the instrument.

The statistical population of this research included all student teachers studying at various campuses of Farhangian University in the academic year 2025–2026. Using the convenience sampling method, 828 student teachers (485 females and 343 males) participated in this study. The participants of this research consisted of student teachers studying in various undergraduate majors who, in terms of academic year, were distributed across the first to fourth years. The age range of the participants was between 18 and 26 years. The data collection process was conducted online. Prior to administering the questionnaire, the research objectives were explained to the participants and informed consent was obtained from them to participate in the study. They were also assured that the information would be analyzed anonymously and solely for research purposes. To increase the validity of the factor analyses and prevent overfitting, the total sample was randomly divided into two independent subsamples of 414 participants each; the first subsample was used for exploratory factor analysis (EFA) and the second subsample for confirmatory factor analysis (CFA). This sample size (828 participants), in addition to complying with common psychometric indices based on the ratio of the number of items to respondents (such as the criterion of a minimum of 10 respondents per item; Kline, 2016), also possesses the necessary statistical adequacy and high desirability according to the

Krejcie and Morgan (1970) sample size determination table, which specifies a maximum required sample size of 384 for large populations.

The instrument used in this research is the Persian version of the Artificial Intelligence Literacy Scale in Second Language Writing (L2W-SAILS) derived from the study of Xu et al. (2025). This scale consists of 22 items that, based on a coherent theoretical framework, measure four key dimensions of artificial intelligence literacy in the context of second language writing. These dimensions are: 1. Understanding (items 1 to 6), which measures underlying knowledge and attitude toward the nature of artificial intelligence; 2. Use (items 7 to 12), which is dedicated to practical skills and learners' behaviors in applying artificial intelligence tools; 3. Evaluation (items 13 to 17), which assesses the ability of critical judgment and informed selection of tools; and 4. Ethics (items 18 to 22), which focuses on ethical considerations and privacy. Respondents indicated their degree of agreement with each item on a five-point Likert scale (from 1: Strongly Disagree to 5: Strongly Agree). The results of the exploratory factor analysis in the present research (Table 2), while confirming desirable factor loadings for all 22 items, re-identified the aforementioned four-dimensional structure in the context of Iranian student teachers.

For the preparation of the instrument, the process of translation and psychometric adaptation was carried out based on the standard forward-backward method in accordance with Brislin's (1986) model. In the first stage, the original scale was independently translated into Persian by two translators proficient in English and Persian. After synthesizing the versions and achieving a unified version, this text was back-translated into English by two other independent translators who were unaware of the original version of the instrument. Minor conceptual and linguistic differences were examined and corrected in a session attended by three specialists in English language and psychometrics. In the next stage, to establish content and face validity, the resulting version was provided to a panel of specialists consisting of five professors in the fields of English language teaching and educational technology, and after applying their suggested revisions, the final version was prepared. Finally, prior to the main administration and in order to resolve any possible ambiguity in the comprehension of the items, a preliminary study was conducted on a small sample consisting of 30 student teachers from the target population (who were not included in the final analyses). The results of this pilot, while confirming the clarity, fluency of the expressions, and appropriate response time (approximately 8 to 10 minutes), indicated desirable initial reliability of the instrument (overall Cronbach's alpha coefficient of 0.88). It should be noted that data collection was conducted online and voluntarily, in compliance with ethical principles.

Data analysis was performed in two main stages. First, in order to ensure the assumptions of statistical analysis, the assumption of normality of data distribution was examined through the indices of skewness and kurtosis. In the first stage, exploratory factor analysis was conducted using the principal axis factoring extraction method and Promax rotation to identify the initial factor structure; prior to that, sampling adequacy had been confirmed by the KMO index and the significance of the correlation matrix by Bartlett's test of sphericity. In the second stage, confirmatory factor analysis was performed using AMOS software and the maximum likelihood estimation method in order to test the model fit. Given the known sensitivity of the chi-square to degrees of freedom ratio (CMIN/DF) to large sample sizes and the possibility of its overfitting, this index was reported solely as a traditional criterion, and the main evaluation of model fit was based on sample-size-independent indices including the Comparative Fit Index (CFI), the Tucker–Lewis Index (TLI), and the Root Mean Square Error of Approximation (RMSEA) (Kline, 2016). Furthermore, the reliability of the instrument was assessed through Cronbach's alpha coefficient and composite reliability (CR), and construct validity was evaluated through convergent validity (AVE) and discriminant validity (based on the Fornell–Larcker criterion) (Hair et al., 2017). Finally, to examine criterion-related validity, Pearson's correlation test was used to measure the relationship between the total scores of the present scale and the scores obtained from a completely independent and external instrument (namely, the Attitude toward AI-Assisted Language Learning scale).

3. Interpretations and Discussion

The study sample consisted of 828 student teachers, whose demographic characteristics are reported in detail below. In terms of gender, 485 participants (58.6%) were female and 343 (41.4%) were male. The age range of the participants was between 18 and 26 years (mean = 21.18, standard deviation = 1.89). The distribution of academic majors showed that the highest frequencies belonged to Elementary Education (269 participants; 32.5%), Persian Language and Literature (220 participants; 26.6%), and English Language Education (80 participants; 9.7%). The remaining participants were studying in the fields of Health (60 participants; 7.2%), Arabic (52 participants; 6.3%), Theology (48 participants; 5.8%), Counseling (47 participants; 5.7%), Educational Affairs (27 participants; 3.3%), and Social Education (25 participants; 3%).

Regarding technology use experience, 796 participants (96.1%) had prior experience working with artificial intelligence tools, while 32 participants (3.9%) reported no previous experience in this area. Concerning the specific use of artificial intelligence for writing skills, 467 participants (56.4%) had experience using these tools, whereas 361 participants (43.6%) had not yet used artificial intelligence for writing texts. Furthermore, the assessment of the participants' second language proficiency level indicated that 51.1% (423 participants) were at

the intermediate level, 37.6% (311 participants) at the beginner level, and 11.3% (94 participants) at the advanced level. The diversity of demographic characteristics and the appropriate distribution of the sample across different proficiency levels and majors strengthen the validity and generalizability of the findings of this research.

In Table 1, the items of the Student Artificial Intelligence Literacy Scale in Second Language Writing are presented along with their descriptive information. Accordingly, the mean scores of the items (based on a 5-point Likert scale ranging from 1: Strongly Disagree to 5: Strongly Agree) ranged from 3.45 to 4.22. In addition, the results of the exploratory factor analysis showed that all items had factor loadings higher than 0.40 on their respective factors, which indicates their adequate capacity to explain the different dimensions of artificial intelligence literacy in second language writing. Therefore, no item was removed due to low factor loading, and all items were retained for entry into the main analyses.

Table 1. Descriptive statistics of the items of the Students' Artificial Intelligence Literacy Scale in second language writing

	Items	**Mean**	**Standard Deviation**
1	I think using AI tools helps improve my second language writing.	4.06	0.77
2	I think using AI tools helps improve the accuracy of my language in second language writing.	3.78	0.97
3	I think using AI tools helps improve the organisation of my second language writing.	3.96	0.86
4	I think using AI tools helps improve the overall quality of my second language writing.	3.96	0.82
5	I think using AI tools helps improve the efficiency of my second language writing.	3.98	0.85
6	I think using AI tools helps improve my second language writing ability.	3.91	0.88
7	I use AI tools to conduct pre-writing planning.	3.89	0.97
8	I use AI tools to improve the quality of my second language writing.	3.99	0.90
9	I use AI tools to improve the accuracy of language in my second language writing.	3.97	0.96
10	I use AI tools to improve the language appropriateness, making my second language writing sound more natural.	3.71	1.02
11	I use AI tools to improve the organisation of my second language writing.	3.89	0.91
12	I can effectively revise my second language writing based	4.03	0.82

	on the suggestions provided by AI tools.		
13	I am able to evaluate the usefulness of AI tools for second language writing.	3.79	0.90
14	I am able to evaluate the limitations of AI tools in supporting second language writing.	3.71	0.91
15	I am able to select the most appropriate AI tool(s) for a specific second language writing task.	3.45	0.98
16	I am able to compare, analyse, and make informed choices among the writing suggestions provided by AI tools.	3.86	0.88
17	I am able to evaluate the authenticity and reliability of the writing suggestions provided by AI tools.	3.64	0.98
18	When using AI tools to support second language writing, I am able to distinguish between ethical and unethical behaviours.	3.90	0.89
19	When using AI tools to support second language writing, I am aware of the relevant ethical principles and practices that should be followed.	3.93	0.92
20	When using AI tools to support second language writing, I am able to adhere to relevant ethical principles and practices.	4.14	0.78
21	When using AI tools to support second language writing, I am aware of potential risks such as privacy and information security.	4.22	0.80
22	I remain vigilant to unethical behaviours	4.12	0.84

Prior to conducting the exploratory factor analysis, sample adequacy and the suitability of the correlation matrix were examined. The KMO index value was obtained as 0.935, which indicates excellent sample adequacy for factor analysis. In addition, Bartlett's test of sphericity was significant ($\chi^2 = 5049.468$, $df = 231$, $p < 0.001$), which indicates the existence of significant correlations among the variables and the appropriateness of the data for factor extraction. Given the significance of the chi-square value, it was determined that there is high correlation among the items within each of the factors, and no particular correlation is observed between the items of one factor and the items of other factors. Overall, based on the results of the KMO and Bartlett tests, the adequacy of the studied sample for conducting factor analysis was confirmed.

Exploratory factor analysis was performed using the principal axis factoring extraction method and the Promax rotation method. The selection of the principal axis factoring method was made because this method, by focusing on the common variance among the items, provides a very precise estimation for discovering latent constructs in psychometric instruments (Kline, 2016). Based on the criterion of eigenvalue greater than 1 and examination of the scree plot, four factors were extracted. These four factors explained a total of 56.15% of the total variance of the variables, which indicates the appropriate explanatory power of the factorial structure of the scale.

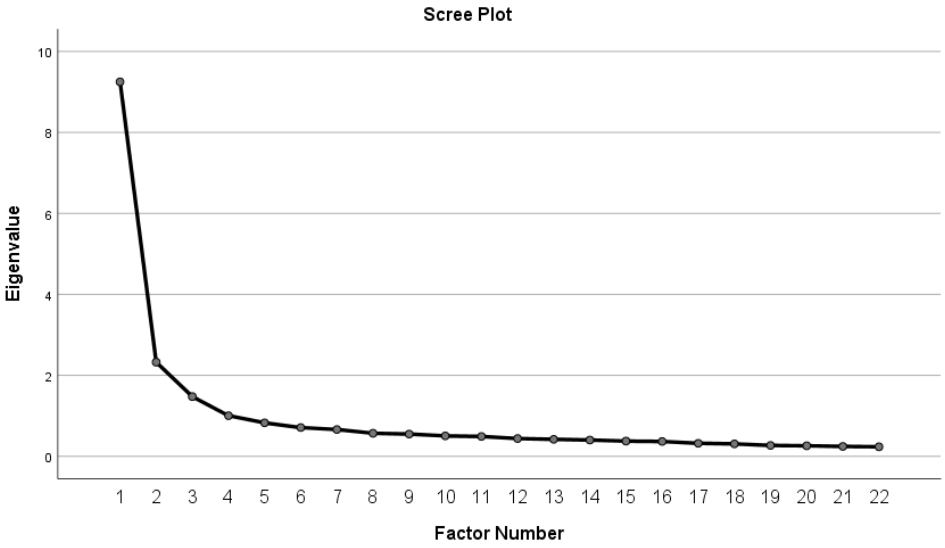


Figure 1. Scree plot of the AI literacy scale in L2 writing

As shown in Figure 1, the slope of the scree plot decreases markedly after the fourth factor, supporting the four-factor structure of the scale. Table 2 presents a summary of the results of the exploratory factor analysis for the student AI literacy scale in L2 writing.

Table 2. Summary of exploratory factor analysis results for the student AI literacy scale in L2 writing

Item No.	Factor 1	Factor 2	Factor 3	Factor 4	Eigenvalue	Explained Variance (%)
1	0.57				8.82	40.14
2	0.66					
3	0.89					
4	0.70					
5	0.76					
6	0.73					
7		0.68			1.90	8.61
8		0.80				
9		0.57				
10		0.47				

11		0.57				
12		0.49				
13			0.63			
14			0.67			
15			0.88		1.04	4.75
16			0.68			
17			0.59			
18				0.57		
19				0.58		
20				0.84	0.59	2.67
21				0.55		
22				0.85		

Based on the results of Table 2, the 22 items of the scale are reducible to four factors. It is noteworthy that the factor loadings of all items are above 0.40 and are acceptable. An important point is that the factorial structure extracted from the exploratory factor analysis of the Persian version of the scale is exactly similar to the factorial structure of the scale in the study by Xu et al. (2025). Therefore, following the original version of the scale, the first, second, third, and fourth factors were named “Understanding,” “Use,” “Evaluation,” and “Ethics,” respectively. The eigenvalue of the Understanding component is equal to 8.82, which explains 40.14% of the total variance. The Use component, with an eigenvalue of 1.9, has explained 8.61% of the total variance. The Evaluation component, with an eigenvalue of 1.04, has explained 4.75% of the total variance, and finally, the Ethics component, with an eigenvalue of 0.59, has explained 2.67% of the total variance.

In total, the identified components have been able to explain 56.15% of the total variance. In psychometrics, the remaining 43.85% of the variance represents the specific variances of the items and the usual measurement error in behavioral science studies; compared to similar instruments, the currently explained variance indicates highly desirable construct validity of the scale. In the initial examination based on Kaiser’s criterion (eigenvalue greater than 1), three factors were extractable. However, considering the careful examination of the slope of the scree plot, the strong theoretical support of the original model (Xu et al., 2025), and the necessity of maintaining the integrity of the dimensions of artificial intelligence literacy, the four-factor structure was extracted as the final model. After it was determined through exploratory factor analysis that the scale items are reducible to four underlying factors, an attempt was subsequently made to ensure the construct validity of the data collection instrument through another method, namely covariance-based confirmatory factor analysis. Prior to conducting the confirmatory factor analysis, the normality of the data distribution in the second sample (N = 414) was examined. For this purpose, the skewness and kurtosis indices were calculated for the

questionnaire items. The results showed that the skewness values of all items ranged from 0.37 to 1.05 and the kurtosis values ranged from 0.39 to 0.90. Given that these values fall within the acceptable range (±2), the deviation from normality is negligible and the necessary conditions for using the maximum likelihood estimation method in confirmatory factor analysis are provided.

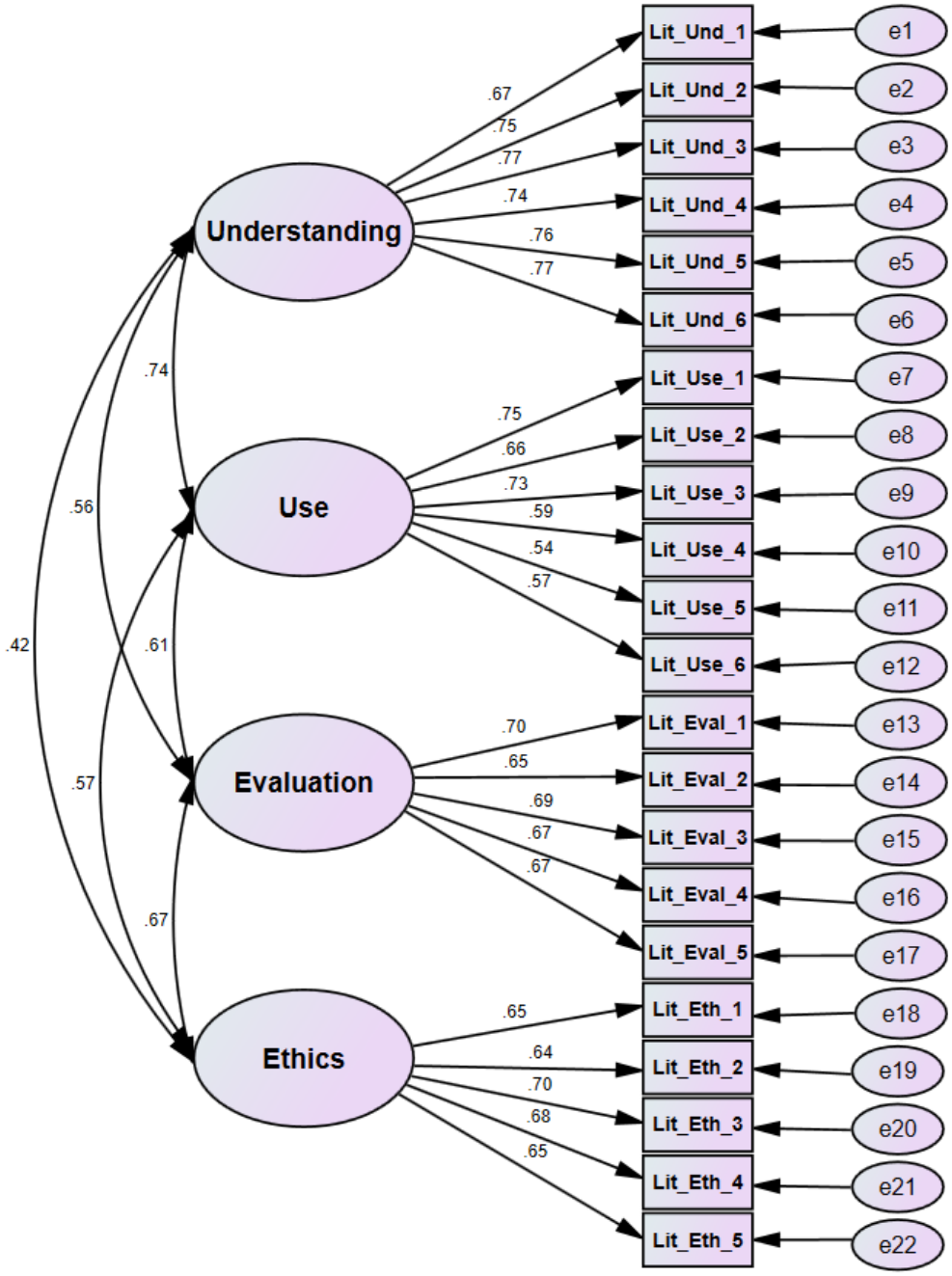


Figure 2. First-Order Confirmatory Factor Analysis (CFA) Model

Table 3. Summary of the Results of Confirmatory Factor Analysis

Component	**Item**	**Factor Loading**	**t-value**
Understanding	1	0.67	–
	2	0.755	13.43
	3	0.766	13.60
	4	0.743	13.26
	5	0.764	13.56
	6	0.771	13.67
Use	7	0.75	–
	8	0.664	12.72
	9	0.735	14.08
	10	0.592	11.32
	11	0.538	10.27
	12	0.572	10.93
Evaluation	13	0.703	–
	14	0.651	11.61
	15	0.69	12.22
	16	0.672	11.95
	17	0.668	11.88
Ethics	18	0.652	–
	19	0.637	10.58
	20	0.697	11.34
	21	0.672	11.09
	22	0.653	10.80

Finally, the model fit indices were reported to evaluate the overall goodness of fit of the proposed model. In the tested model, the chi-square statistic was 519.958 with 203 degrees of freedom. Given that the ratio of chi-square to degrees of freedom ($\chi^2/df = 2.561$) was below the recommended threshold of 3, the model fit was considered acceptable based on this criterion.

The root mean square error of approximation (RMSEA), another widely used and important fit index, indicates good model fit when its value is below 0.08. In the present study, the RMSEA value was 0.061, suggesting a satisfactory fit of the model to the data.

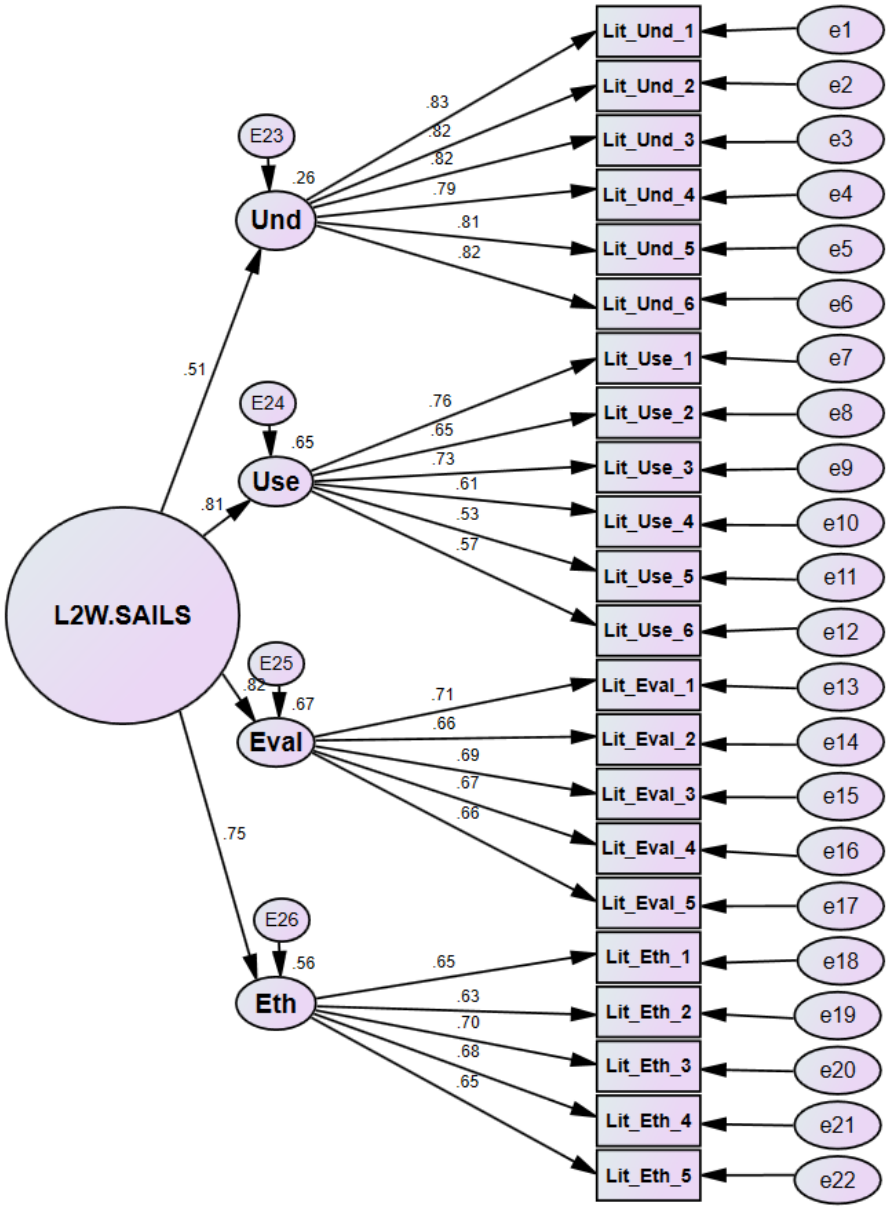


Figure 3. Second-order confirmatory factor analysis model

Another highly important index is the Comparative Fit Index (CFI), for which values equal to or higher than 0.90 indicate good model fit. In this research, the Comparative Fit Index (CFI) was obtained as 0.915, the Incremental Fit Index (IFI) as 0.916, and the Non-Normed Fit Index (TLI) as 0.903, all of which are higher than the standard threshold (0.90) and confirm the desirable fit of the model. In addition, the value of the Root Mean Square Residual (RMR) is equal to 0.052, which indicates negligible measurement error and a very good model fit. Although the NFI and AGFI indices (equal to 0.87) are slightly lower than the 0.90 boundary, considering that these indices are strongly influenced by large sample size (828 participants) and taking into account the excellent fit of the other main indices and the significant factor

loadings of all 22 items, overall the factorial structure of the Persian version of the Artificial Intelligence Literacy Scale in Second Language Writing (L2W-SAILS) was confirmed.

After confirmation of the first-order model, the second-order confirmatory factor analysis model was tested in order to examine the hierarchical structure of the scale. The results obtained from the standardized factor loadings showed that all regression paths from the higher-order latent variable (artificial intelligence literacy) to the four dimensions are positive and significant at the level of ($P < 0.001$). The highest factor loading belonged to the Evaluation component (0.82), followed by the Use (0.81) and Ethics (0.75) components. The Understanding component also showed an acceptable factor loading of 0.51 on the overall construct. Furthermore, the R^2 values (explained variance) indicated that artificial intelligence literacy explains 67%, 65%, 56%, and 26% of the variance of the Evaluation, Use, Ethics, and Understanding dimensions, respectively. The fit indices of the second-order model were examined. The chi-square to degrees of freedom ratio is equal to 3.33, which, given the sample size, falls within the expected range for large models (Wheaton et al., 1977; Marsh & Hocevar, 1985). Other fit indices also indicated desirable model fit (CFI = 0.94, TLI = 0.92, RMSEA = 0.06). Overall, the general fit of the hierarchical model was confirmed, which indicates that the four extracted dimensions are indicators of a single and hierarchical construct (artificial intelligence literacy).

In order to finally examine the psychometric properties of the scale, the reliability indices (Cronbach's alpha and composite reliability) and construct validity (convergent and discriminant) were calculated on the second subsample (N = 414). The results showed that the Cronbach's alpha coefficients of the four components of Understanding, Use, Evaluation, and Ethics were obtained as 0.868, 0.803, 0.784, and 0.793, respectively. The Cronbach's alpha coefficient of the total scale was also 0.931. Since all of these coefficients are higher than 0.70, confidence was also obtained regarding the reliability of the Persian version of the Artificial Intelligence Literacy Scale in Second Language Writing (L2W-SAILS). In addition, the composite reliability (CR) value for all components was obtained as 0.88, 0.81, 0.81, and 0.80, respectively, all of which are higher than the recommended threshold of 0.7 and confirm the desirable reliability of the instrument. In examining convergent validity, the average variance extracted (AVE) value for the Understanding component was equal to 0.56, which is higher than the criterion. For the three components of Use (0.41), Evaluation (0.46), and Ethics (0.44), although the AVE value is less than 0.5, based on the view of Fornell and Larcker (1981) and Joseph et al. (2022), because the composite reliability (CR) value of these components is substantially higher than 0.6, the convergent validity of the construct was accepted. Furthermore, discriminant validity was examined based on the Fornell–Larcker criterion. The

results showed that the square root of AVE for the Understanding (0.74), Use (0.64), Evaluation (0.67), and Ethics (0.66) components is greater than the correlation of these constructs with the other dimensions (except for the correlation of 0.74 between Understanding and Use). Given the confirmation of the confirmatory model fit and the high reliability of the dimensions, the overlap between these two dimensions in the context of the present research is negligible, and overall, the distinction among the scale dimensions and its discriminant validity were confirmed. It should be noted that the conceptual overlap of these two dimensions in the early stages of interaction with artificial intelligence has also been reported in the literature. In the final step, in order to examine the criterion-related validity of the Artificial Intelligence Literacy Scale in Second Language Writing with the Attitude toward Second Language Learning with the Help of Artificial Intelligence scale, it was tested in the entire research sample (828 participants). The results of the Pearson correlation test indicated the existence of a positive, direct, and strong relationship between these two constructs ($r = 0.733$ and $P < 0.001$).

After ensuring the validity and reliability of the Persian version of the scale, the status of students' artificial intelligence literacy in second language writing among the sample individuals was subsequently examined.

Table 4. Assessment of Students' Artificial Intelligence Literacy in Second Language Writing

Variable	**N**	**Observed Mean**	**Standard Deviation**	**Theoretical Mean**	**t-value**	**Degrees of Freedom**	**Significance Level**
Understanding	828	3.76	0.80	3	27.30	827	0.001
Use	828	3.83	0.72	3	33.29	827	0.001
Evaluation	828	3.67	0.74	3	26.11	827	0.001
Ethics	828	3.95	0.69	3	39.50	827	0.001
Total Scale Score	828	3.80	0.59	3	39.27	827	0.001

The results of the one-sample t-test (assuming a theoretical mean of 3 on the Likert scale) in Table 4 show that the mean of students' artificial intelligence literacy in second language writing was equal to 3.8 and its standard deviation was 0.59. The t value was equal to 39.27 and the obtained significance level was 0.001. Given the significant higher mean than the theoretical average level (3), it can be concluded that the students have a positive view toward their level of literacy and capability in applying artificial intelligence in the writing process. Although these results are based on the students' self-assessment, they indicate their understanding of the practical application of artificial intelligence in language skills.

4. Conclusion

The main aim of this research was to validate the Persian version of the Artificial Intelligence Literacy Scale in Second Language Writing (L2W-SAILS), which was developed by Xu et al. (2025), within the context of Iranian higher education. The findings obtained from the analysis of data from 828 student teachers showed that this instrument possesses powerful psychometric properties for measuring this emerging construct. The results of exploratory and confirmatory factor analyses indicated that the Persian version of this scale precisely follows the same four-factor structure of the original version (Xu et al., 2025), including Understanding, Use, Evaluation, and Ethics, which collectively explain 56.15% of the total variance. This finding is completely consistent with the factorial structure presented in the original version. Furthermore, the confirmation of the model in the confirmatory factor analysis with desirable fit indices (RMSEA = 0.061; CFI = 0.915) indicates that the identified dimensions fit well with the data collected in the cultural and educational context of Iran.

The confirmation of the second-order model and the desirable fit of the structural indices in this research indicate that the four dimensions of artificial intelligence literacy (Understanding, Use, Evaluation, and Ethics) in the Iranian educational context are clustered in the same manner as was reported in the original study. This alignment, despite the linguistic and cultural differences between the two research contexts, provides empirical evidence for the transcultural and global nature of a single and coherent construct named artificial intelligence literacy in the domain of second language writing. The mean scores in the Ethics dimension (3.95) showed that students have high awareness regarding unethical behaviors and privacy risks. This finding can be explained by the fact that in the student-teacher community, due to its professional and educational nature, there is high awareness toward unethical behaviors and privacy risks. In other words, in the student-teacher community, sensitivity toward "academic integrity" is higher than other dimensions. On the other hand, obtaining the lowest score in the Evaluation dimension (3.67) is consistent with the results of the original research (Xu et al., 2025). This may indicate a skills gap; meaning that although students appear capable in the practical use of tools, they require more training in critical analysis, identifying limitations, and making informed selections of artificial intelligence outputs. The evaluation and selection of the appropriate tool depend on students' knowledge and experience in working with multiple artificial intelligence tools and recognizing the appropriate contexts for their use (Ou et al., 2024). However, some students may lack such knowledge and experience and predominantly rely on the most well-known and influential tool, such as ChatGPT (Warschauer et al., 2023; Teng, 2024). This issue reveals the necessity of including explicit instruction in the field of critical evaluation and matching the tool with the writing purpose in teacher education curricula. The high factor loadings in these two sections showed that a large portion of students' artificial

intelligence literacy is merely focused on functional knowledge and the practical application of tools. Overall, the alignment of this research with the original model of Xu et al. (2025) not only confirms the validity of the Persian version but also shows that artificial intelligence literacy in writing is a hierarchical skill that begins with simple understanding and ends with critical evaluation. The gap between the Use and Evaluation scores in this research highlights the necessity of revising teacher education curricula to move from instrumental use toward intelligent and critical use. The findings from the one-sample t-test (Table 4) showed that the mean artificial intelligence literacy of student teachers in all dimensions is significantly higher than the average level (3). However, a more precise analysis of the means shows that the Ethics and Use dimensions have allocated the highest level to themselves, while the Evaluation dimension is ranked the lowest. This functional gap between the ability to apply tools and the power of critical evaluation of their outputs is empirical evidence for the necessity of revising teacher education curricula; such that trainings should be directed from focusing on mere technical skills toward strengthening analytical competencies and critical judgment.

The measurement precision of the instrument was guaranteed with a total Cronbach's alpha of 0.931. In the validity section, citing the view of Fornell and Larcker, due to the composite reliability (CR) being higher than 0.80, convergent validity was confirmed. In addition, the strong and positive correlation (0.733) between artificial intelligence literacy and attitude toward language learning explained the criterion-related validity of the instrument in predicting motivational variables. Finally, the results showed that the mean artificial intelligence literacy of students in second language writing is significantly higher than the average level. However, the confirmation of the hierarchical structure of the scale indicates that to achieve full literacy, students must go beyond the stages of Understanding and Use and attain the higher levels of critical evaluation and ethical commitment. University professors can use the Artificial Intelligence Literacy Scale in Second Language Writing to identify students' weaknesses in the writing process and direct curricula toward strengthening critical thinking in confronting artificial intelligence.

The findings of this research, consistent with the model of Xu et al. (2025), indicate the level of students' self-assessment of their artificial intelligence literacy in the second language learning process. The scale validated in this study provides a precise instrument for measuring these perceived competencies, which can be considered as a basis for developing educational interventions in the Iranian university context. The ultimate goal of this framework is to guide students toward the intelligent utilization of artificial intelligence tools so that they are used as a complement, facilitator of the learning process, and improver of writing skills.

4.1 Limitations of the Study

The present research faced limitations that require attention in interpreting the findings. First, the use of the convenience sampling method and the online nature of data collection may make the generalizability of the results to all student teachers or students of non-educational majors cautious. In addition, reliance on individual reports in the scale increases the possibility of response bias (such as social desirability) and may overshadow the actual estimation of the level of practical skills. Furthermore, the lack of control of environmental intervening variables such as the type of platforms used and the level of internet access was also among the other limitations of this study. From the perspective of research boundaries, this study focused solely on the context of second language writing among student teachers, and the examination of intervening variables such as gender differences or prior experience in using artificial intelligence was not within the scope of the objectives of this study.

4.2 Recommendations for Further Research

In line with the development of future research and given that self-assessment instruments may not cover all cognitive aspects of users, it is suggested that researchers utilize a mixed-methods approach. In particular, the use of in-depth interviews alongside quantitative analysis can explore the hidden layers of students' decision-making process in confronting artificial intelligence errors. Furthermore, future research should integrate multiple data sources such as observation of the writing process and analysis of actual interactions with artificial intelligence tools so that the theoretical structure of artificial intelligence literacy in second language writing is enhanced and a deeper evaluation is provided. In addition, conducting longitudinal studies to monitor the evolution of artificial intelligence literacy during the period of study and comparing it across different specialized domains can provide a more comprehensive understanding of the dynamics of this construct in the higher education system.

From an applied perspective, the findings of this research emphasize the necessity of revising teacher education curricula so that by designing specialized educational workshops, student teachers are directed from the level of mere instrumental use toward critical evaluation and assessment of the credibility of artificial intelligence outputs. This educational approach should encourage students to confront artificial intelligence tools in a manner that improves their writing skills. Finally, educational policymakers should, by formulating transparent ethical guidelines and integrating artificial intelligence literacy into the syllabi of relevant courses, provide a platform for utilizing the potential of this technology.

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