

Artificial intelligence literacy and foreign language confidence among university second language learners

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ABSTRACT

This quantitative correlational-predictive study investigated the relationship between artificial intelligence (AI) literacy and foreign-language confidence among university second-language learners. Two samples were recruited: a psychometric sample (N=341) for scale validation and a main sample (N=541) for hypothesis testing. Participants completed the artificial intelligence literacy scale (AELS), measuring awareness, usage, evaluation, and ethics dimensions, and the foreign language confidence scale (FLCS), assessing foreign language competence, sense of linguistic security, and sense of linguistic ownership. Pearson correlation analyses revealed statistically significant positive associations between all AI literacy and foreign language confidence dimensions ($r=.398-.574$). Simple linear regression demonstrated that AI literacy significantly predicted foreign language confidence ($F(1, 539)=270.742, p<.001, R^2=.334$), with each unit increase in AI literacy corresponding to a .736-unit increase in foreign language confidence. These findings suggest that systematically embedding AI literacy instruction into language curricula may serve as a meaningful lever to strengthen learners' psychological readiness and communicative confidence in the target language.

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1. INTRODUCTION

The integration of artificial intelligence (AI) technologies into higher education has fundamentally transformed the landscape of foreign language learning, creating unprecedented opportunities and challenges for second language (L2) learners [1], [2]. As AI-powered language tools become increasingly embedded in university curricula, understanding how students navigate these technological environments has emerged as a critical research priority [3], [4]. This study investigates the relationship between two pivotal constructs in this evolving educational context: AI literacy and foreign language confidence. AI literacy encompasses learners' multidimensional competence to understand, utilize, and critically evaluate AI systems in academic settings, including technical knowledge, operational skills, and ethical awareness [5]–[7]. Conversely, foreign language confidence reflects students' self-efficacy, reduced anxiety, enjoyment, and willingness to communicate when engaging with target languages through AI-mediated platforms [8]–[10].

The rapid integration of generative AI into language education has fundamentally shifted the traditional L2 learning paradigm, rendering AI literacy an essential competency for contemporary learners. Generative AI technologies have transformed language learning from classroom-bound instruction to ubiquitous, AI-mediated experiences that span multiple platforms and contexts [11], [12]. These systems enable personalized, adaptive learning trajectories through real-time feedback, individualized input, and continuous diagnostic assessment, redefining pedagogical approaches and learner autonomy while simultaneously demanding critical AI literacy to prevent overreliance and maintain authentic communicative competence [13]–[16]. Consequently, AI literacy has evolved beyond a supplementary digital skill to become a foundational competence that determines learners' capacity to navigate AI-enhanced language-learning environments strategically and ethically [8], [17].

University students and educators are the primary stakeholders at the intersection of AI literacy and foreign language learning, though they are far from homogeneous. Despite widespread assumptions about digital nativity, students exhibit considerable variation in their capacity to ethically and effectively employ AI tools for academic purposes, with everyday technology proficiency failing to guarantee responsible integration in language learning contexts [18]–[20]. Generational and sociocultural divisions persist, as younger learners typically demonstrate higher digital tool proficiency compared to adult learners who may experience heightened technology anxiety and access barriers [21], [22], while educators maintain intermediate digital competence in designing AI-resilient frameworks, creating shared challenges across all stakeholders [23]–[25].

Despite the proliferation of research demonstrating AI's influence on language performance and affective variables, a critical gap persists in empirically linking learners' technical AI proficiency to their psychological confidence in L2 production. Existing studies predominantly examine AI as an instructional intervention, measuring gains in speaking and writing without assessing learners' technical competence in operating AI tools [26], [27]. While research documents confidence and anxiety changes following chatbot or metaverse-based instruction, these studies rarely quantify participants' AI literacy levels [28]–[31]. Although Zhang *et al.* [8] connected AI literacy to willingness to communicate, the specific pathway from technical AI proficiency to L2 confidence in speaking and writing remains underexplored. Systematic reviews explicitly call for deeper investigation into learner emotions and procedural AI knowledge in language production contexts [1], [32].

The relationship between AI literacy and foreign language confidence can be theoretically grounded in the integration of self-efficacy theory, the technology acceptance model (TAM), and self-determination theory (SDT). Self-efficacy theory posits that learners' beliefs in their technological capabilities directly influence engagement, performance, and persistence, with higher AI self-efficacy reducing anxiety and enhancing learning outcomes [33]–[35]. TAM explains how perceived usefulness and ease of use shape learners' attitudes and intentions toward AI tools, with technological self-efficacy serving as a critical antecedent to these perceptions [36]–[39]. Additionally, SDT emphasizes that AI tools supporting learners' needs for competence and autonomy foster intrinsic motivation and self-regulated learning [38], [40], [41], collectively explaining how AI literacy may enhance or diminish learners' psychological confidence in language production.

While AI-mediated language learning demonstrably reduces foreign language anxiety and enhances confidence through non-judgmental feedback, personalized support, and emotionally adaptive scaffolding, critical tensions emerge when supportive scaffolds transition into dependency-inducing crutches [9], [42], [43]. AI risks becoming counterproductive when autonomous usage occurs without pedagogical framing, potentially generating technostress, cognitive overload, and diminished self-regulation [26], [32], [44]. Furthermore, excessive reliance on AI-generated feedback may undermine learners' strategic competence and critical engagement, particularly when teacher mediation is absent [44]–[46]. The efficacy of AI support consequently depends on the implementation design: structured integration with human instruction fosters confidence and autonomy, whereas unmediated dependence risks transferring anxiety from language use to technology [26], [45]–[47].

This study addresses the identified knowledge gap by systematically examining the relationship between AI literacy and foreign language confidence among university L2 learners through rigorous quantitative analysis. The research aims to quantify the correlation between AI literacy scores and self-reported foreign language confidence measures, parallel to investigations documenting modest to moderate associations between literacy and confidence constructs in health and financial domains [48]–[50]. Finally, regression modeling examines how AI literacy predicts foreign language confidence, employing analytical approaches demonstrated in studies in which knowledge and confidence jointly influence behavioral patterns [51]–[54].

While prior investigations have linked AI literacy to willingness to communicate as a behavioral intention, the present study uniquely advances this line of inquiry by targeting foreign language confidence as a multidimensional psychological construct encompassing competence beliefs, linguistic security, and sense

of ownership-dimensions that are conceptually and empirically distinct from anxiety reduction or communicative willingness [8]. Methodologically, the sequential use of a dedicated psychometric sample for instrument validation prior to hypothesis testing in a separate main sample distinguishes this study from predominant single-sample correlational designs in the AI–English as a foreign language (EFL) literature, thereby enhancing the psychometric rigor and interpretive confidence of the reported associations [26], [32].

Building on these theoretical and empirical foundations, the present study addresses the following research questions:

- What is the nature and strength of the bivariate relationships between the dimensions of AI literacy (awareness, usage, evaluation, and ethics) and the dimensions of foreign language confidence (foreign language competence, sense of linguistic security, and sense of linguistic ownership) among university L2 learners? (RQ1)
- To what extent does overall AI literacy significantly predict overall foreign language confidence among university L2 learners? (RQ2)

Consistent with the theoretical frameworks of self-efficacy theory, TAM, and SDT, it is hypothesized that: i) all AI literacy dimensions will demonstrate statistically significant positive correlations with all foreign language confidence dimensions (H1), and ii) overall AI literacy will serve as a significant positive predictor of overall foreign language confidence (H2).

2. METHOD

2.1. Participants

This study employed two distinct samples: a psychometric sample for scale validation and a main sample for hypothesis testing. Both samples were recruited using convenience sampling, whereby students enrolled in English and French language programs at the targeted faculties during the first semester of the 2025/2026 academic year were invited to participate voluntarily. The psychometric sample comprised 341 university students (39.9% male, 60.1% female) aged 18-23 years ($M=21.33$, $SD=1.62$), while the main sample consisted of 541 students (74.7% male, 25.3% female) aged 18-23 years ($M=20.34$, $SD=1.88$). All participants were active users of AI technologies in their language learning.

With respect to foreign language proficiency, all participants were enrolled in accredited English or French language degree programs at Al-Azhar University, indicating an intermediate to upper-intermediate proficiency level consistent with their academic standing. Formal standardized proficiency assessments were not administered as part of this study; proficiency was therefore operationalized through participants' academic year and program enrollment, which served as proxies for cumulative language exposure. It should be noted that the main sample exhibited a substantial gender imbalance (74.7% male, 25.3% female), which is attributable to the institutional structure of the recruiting faculties (the Faculty of Education for Males and the Faculty of Humanities for Females) and the proportional enrollment figures at each site during the data collection period. This imbalance may limit the generalizability of findings across gender groups and is explicitly acknowledged as a limitation of the present study. The demographic characteristics of both samples are presented in Table 1. Participation was voluntary and all students provided informed consent prior to completing the study instruments.

Table 1. Demographic characteristics of psychometric and main samples

Variable	Category	Psychometric sample (N=341)		Main sample (N=541)	
		F	%	F	%
Major	English	200	58.7	173	32.0
	French	141	41.3	220	40.7
Gender	Male	136	39.9	404	74.7
	Female	205	60.1	137	25.3
Academic year	First	59	17.3	192	35.5
	Second	22	6.5	53	9.8
	Third	99	29.0	128	23.7
	Fourth	161	47.2	168	31.1
Residence	Urban	145	42.5	180	33.3
	Rural	196	57.5	361	66.7

2.2. Instruments

Artificial intelligence literacy scale (AILS), to assess participants' multidimensional competence in understanding and utilizing AI systems [55]. The scale comprises 12 items distributed equally across four dimensions: i) awareness (3 items); ii) usage (3 items); iii) evaluation (3 items); and iv) ethics (3 items).

Respondents rated each item on a 7-point Likert scale. Confirmatory factor analysis with the psychometric sample demonstrated acceptable model fit indices (Chi-square to degrees of freedom ratio (χ^2/df)=2.897, goodness of fit index (GFI)=.936, adjusted goodness of fit index (AGFI)=.901, comparative fit index (CFI)=.930, root mean square error of approximation (RMSEA)=.075). Reliability coefficients for the four dimensions ranged from adequate to good, with omega coefficients of .736 (awareness), .731 (usage), .753 (evaluation), and .820 (ethics), and Cronbach's alpha coefficients of .733, .723, .750, and .817, respectively.

Foreign language confidence scale (FLCS), which assesses learners' confidence and self-efficacy in using English across three primary dimensions: foreign language competence, sense of linguistic security, and sense of linguistic ownership [56]. The instrument consists of 15 items rated on a 6-point Likert scale ranging from 1 (strongly disagree) to 6 (strongly agree). Confirmatory factor analysis yielded satisfactory fit indices (χ^2/df =2.689, GFI=.903, AGFI=.870, CFI=.942, RMSEA=.070). The scale demonstrated strong internal consistency, with omega and Cronbach's alpha coefficients of .876 for foreign language competence, .846 and .841 for sense of linguistic security, .834 and .827 for sense of linguistic ownership, and excellent overall reliability (ω =.933, α =.931).

2.3. Translation procedure

Both instruments were originally developed in English and required translation into Arabic, the participants' native language. A rigorous translation-back-translation procedure was implemented involving three expert translators with advanced proficiency in both English and Arabic. The translators independently translated the scales from English to Arabic, after which the Arabic versions were back-translated to English by different experts. The research team reviewed all translations to ensure semantic equivalence, cultural appropriateness, and conceptual accuracy. Any discrepancies were resolved through expert consensus, resulting in final Arabic versions that maintained the psychometric integrity of the original instruments.

Following the translation process, a preliminary pilot administration of both Arabic versions was conducted with a small group of 30 university students drawn from the same target population but excluded from both the psychometric and main samples. Pilot participants were asked to complete the instruments and flag any items perceived as ambiguous, culturally inappropriate, or linguistically unclear. Feedback was reviewed by the research team and the expert translators, and minor linguistic refinements were made accordingly to enhance clarity without altering item meaning. To further ensure linguistic and conceptual equivalence between the original English and translated Arabic versions, the confirmatory factor analyses conducted with the psychometric sample were used to evaluate whether the translated instruments reproduced the factorial structures reported for the original scales. The acceptable fit indices obtained for both the AILS (χ^2/df =2.897, RMSEA=.075) and the FLCS (χ^2/df =2.689, RMSEA=.070) provided empirical support for the structural equivalence of the Arabic versions, indicating that the constructs were measured consistently across the translated instruments.

2.4. Data analysis

Data analysis was conducted using SPSS-27 and AMOS-26. Confirmatory factor analysis was performed to evaluate the construct validity of both measurement instruments with the psychometric sample. Prior to conducting simple linear regression, a series of assumption checks was performed. Normality of residuals was evaluated using the Kolmogorov-Smirnov test and visual inspection of P-P plots, both of which indicated approximate normality. Homoscedasticity was assessed through examination of scatterplots of standardized residuals against predicted values, revealing no systematic patterns indicative of heteroscedasticity. The Durbin-Watson statistic (d =1.947) confirmed the independence of residuals. No multicollinearity concerns were applicable given the single-predictor design. These checks collectively confirmed that the data satisfied the assumptions required for valid regression inference. Pearson correlation coefficients were calculated to examine the bivariate relationships between AI literacy dimensions and foreign language confidence dimensions.

Simple linear regression was selected as the primary analytical approach to isolate and transparently communicate the direct predictive relationship between overall AI literacy and overall foreign language confidence, consistent with the study's focused bivariate research objectives. Control variables such as gender, academic year, and residence were not included in the regression model, as the primary aim of this study was to establish the baseline direct predictive relationship between AI literacy and foreign language confidence rather than to partition variance across demographic covariates. This decision is consistent with the study's correlational-predictive design and its theoretically motivated focus on the bivariate literacy-confidence pathway. Future research employing larger and more demographically balanced samples is encouraged to examine the moderating roles of these variables systematically.

3. RESULTS

The present study examined the relationship between AI literacy and foreign language confidence among 541 university L2 learners. The analysis proceeded in two stages: first, examining the bivariate correlations between AI literacy dimensions and foreign language confidence dimensions; second, testing the predictive relationship between overall AI literacy and overall foreign language confidence through simple linear regression. Pearson correlation coefficients were calculated to examine the associations between the four dimensions of AI literacy (awareness, usage, evaluation, and ethics) and the three dimensions of foreign language confidence (foreign language competence, sense of linguistic security, and sense of linguistic ownership). As presented in Table 2, all correlations between AI literacy dimensions and foreign language confidence dimensions were statistically significant at the .01 level, indicating systematic positive relationships across all measured constructs.

The correlations between individual AI literacy dimensions and foreign language confidence dimensions ranged from moderate to moderately strong. Among the AI literacy dimensions, evaluation demonstrated the strongest associations with all three foreign language confidence dimensions, with correlation coefficients of .542 with foreign language competence, .550 with sense of linguistic security, and .514 with sense of linguistic ownership. The awareness dimension showed correlations of .497, .482, and .472 with the three confidence dimensions respectively, while usage exhibited correlations of .471, .473, and .479. The ethics dimension displayed the weakest associations among the four AI literacy dimensions, with correlations of .431, .407, and .398 with the respective confidence dimensions.

When examining overall AI literacy in relation to the foreign language confidence dimensions, moderate positive correlations emerged across all three dimensions. Overall, AI literacy correlated .550 with foreign language competence, .542 with sense of linguistic security, and .527 with sense of linguistic ownership. The correlation between overall AI literacy and overall foreign language confidence was .578, indicating a moderately strong positive association. These findings indicate that students with higher AI literacy consistently reported greater confidence across all measured aspects of foreign-language use.

Inspection of Table 2 reveals notably high intercorrelations among the three foreign language confidence dimensions ($r=.789-.815$), which, while consistent with the theoretically proposed multidimensional structure of the construct [56], suggest possible construct overlap that future bifactor modeling may better clarify. Additionally, as both constructs were assessed concurrently via self-report instruments, common method variance (CMV) may have partially inflated the observed associations [57]. The use of distinct response formats for the two scales—seven-point for the AILS and six-point for the FLCS—partially mitigates this concern, though future studies should employ stronger procedural and statistical CMV controls.

Simple linear regression analysis was conducted to examine whether overall AI literacy significantly predicted overall foreign language confidence. The analysis of variance for the regression model is presented in Table 3, which demonstrates that the model was statistically significant, $F(1, 539)=270.742$, $p<.001$. This indicates that AI literacy serves as a significant predictor of foreign language confidence. The model accounted for 33.4% of the variance in foreign language confidence ($R^2=.334$), with an adjusted R^2 of .333 indicating minimal shrinkage and confirming the model's stability. The multiple correlation coefficient of .578 reflects a moderately strong positive relationship between the predictor and outcome variables.

Table 2. Correlations between AI literacy dimensions and foreign language confidence dimensions

Variable	1	2	3	4	5	6	7	8	9
Awareness	1								
Usage	.773**	1							
Evaluation	.717**	.760**	1						
Ethics	.658**	.668**	.657**	1					
Total AI literacy	.888**	.905**	.890**	.847**	1				
FL competence	.497**	.471**	.542**	.431**	.550**	1			
Linguistic security	.482**	.473**	.550**	.407**	.542**	.815**	1		
Linguistic ownership	.472**	.479**	.514**	.398**	.527**	.789**	.815**	1	
Total FL confidence	.518**	.508**	.574**	.441**	.578**	.925**	.946**	.927**	1

Note. ** $p<.01$ (two-tailed).

Table 3. Analysis of variance for regression model predicting foreign language confidence from AI literacy

Model	Sum of squares	df	Mean square	F	Sig.
Regression	66227.770	1	66227.770	270.742	.000
Residual	131847.812	539	244.616	-	-
Total	198075.582	540	-	-	-

The regression coefficients are presented in Table 4, revealing that both the constant and the predictor variable were statistically significant. The regression equation can be expressed as: foreign language confidence = $13.675 + .736 \times \text{AI literacy}$. The unstandardized regression coefficient ($B = .736$, $SE = .045$) indicates that for each one-unit increase in AI literacy, foreign language confidence increases by .736 units. The standardized regression coefficient ($\beta = .578$) confirms the substantial contribution of AI literacy to foreign language confidence. Both the constant ($t = 5.391$, $p < .001$) and the predictor variable ($t = 16.454$, $p < .001$) were statistically significant, supporting the validity of the regression model.

These findings demonstrate that AI literacy significantly and positively predicts foreign-language confidence among university second-language learners. Higher levels of AI literacy were associated with correspondingly higher levels of confidence in foreign language use. The regression model confirms that students' competence in understanding and using AI systems is a meaningful predictor of their psychological confidence when engaging with target languages.

Table 4. Regression coefficients for AI literacy predicting foreign language confidence

Model	B	Std. Error	Beta	t	Sig.
(Constant)	13.675	2.537		5.391	.000
Total AI literacy	.736	.045	.578	16.454	.000

4. DISCUSSION

The present study revealed a moderately strong positive relationship between AI literacy and foreign language confidence among university L2 learners, with overall AI literacy accounting for 33.4% of variance in foreign language confidence. The regression analysis demonstrated that each unit increase in AI literacy corresponds to a .736-unit increase in foreign language confidence, suggesting that students' technical competence in understanding and utilizing AI systems substantially influences their psychological readiness for language production. Among AI literacy dimensions, evaluation exhibited the strongest associations with confidence measures, indicating that critical assessment capabilities may be particularly influential in fostering learner confidence. These findings confirm that AI literacy extends beyond mere technical proficiency to become a meaningful psychological resource that shapes learners' self-efficacy and willingness to engage with target languages.

The ethics dimension demonstrated the weakest associations with all foreign language confidence dimensions ($r = .398-.431$). This pattern likely reflects the abstract, metacognitive nature of ethical AI awareness, which operates at a remove from the practical competencies—awareness, usage, and evaluation—that more directly support confident language production. Learners cognizant of AI ethical concerns such as privacy risks and academic integrity violations may experience reflective hesitation that attenuates confidence-building effects [8], [26]. Furthermore, AI ethics remains rarely integrated into university language curricula in any systematic way, leaving learners with inconsistent ethical frameworks that do not yet translate into confident language use behaviors [23]–[25].

These results align with theoretical frameworks proposed by Zhang *et al.* [8], and empirical findings linking AI literacy to willingness to communicate. The moderate correlation coefficients observed parallel associations documented between literacy and confidence constructs in health and financial domains [48]–[50]. The findings support self-efficacy theory and the TAM, demonstrating how technological competence influences learner engagement and reduces anxiety [33]–[35]. However, the results also underscore concerns raised by several studies [26], [32], regarding potential dependency, suggesting that AI literacy's positive influence on confidence must be balanced against risks of technostress and diminished self-regulation when pedagogical mediation is absent.

The findings should be interpreted within Egypt's distinctive educational context. Egyptian university language learners typically navigate large classes, limited individualized feedback, and teacher-centered instruction [23], [24], conditions under which AI tools may assume an amplified confidence-building role by supplying personalized, low-stakes communicative practice otherwise unavailable [9], [42]. Additionally, the sociocultural emphasis on face-saving and public error avoidance prevalent in Arabic-speaking educational settings may render AI's private, non-judgmental feedback particularly effective in reducing linguistic anxiety [28], [29]. These contextual dynamics suggest that Western AI-EFL findings may not transfer directly to Egyptian or broader Global South educational environments.

The findings carry significant implications for language education policy and practice. Universities should prioritize systematic AI literacy development as a foundational component of language curricula rather than treating it as supplementary digital skills training. Educators must design AI-resilient pedagogical frameworks that integrate technical competence training with critical evaluation and ethical

awareness [23]–[25]. Professional development programs should equip instructors to scaffold AI-mediated learning experiences that enhance rather than replace authentic communicative competence. Furthermore, assessment practices must evolve to measure both language proficiency and AI literacy competencies, ensuring students develop strategic autonomy alongside technological proficiency. These integrated approaches may maximize AI's confidence-building potential while mitigating dependency risks.

Several limitations warrant consideration when interpreting these findings. The cross-sectional design precludes causal inferences about whether AI literacy developmentally precedes confidence gains or whether confident learners more readily develop AI competencies. The sample's restriction to Egyptian university students limits generalizability across diverse educational contexts, cultural backgrounds, and institutional AI integration levels. Self-report measures may introduce response bias, particularly regarding socially desirable AI competencies. The study did not differentiate between AI tool types, usage contexts, or pedagogical integration quality, variables that likely moderate the literacy-confidence relationship. Additionally, the absence of longitudinal data prevented examination of how this relationship evolves as learners gain experience with AI-mediated language learning environments over time. The substantial gender imbalance in the main sample (74.7% male) limits generalizability across gender groups and should be addressed in future research.

Future research should employ longitudinal designs to establish temporal precedence and examine how AI literacy and foreign language confidence co-develop throughout learners' educational trajectories. Experimental studies manipulating AI literacy training could clarify causal mechanisms and identify optimal pedagogical interventions. Research should investigate moderating variables including AI tool types, implementation contexts, teacher mediation quality, and cultural factors that may strengthen or weaken the literacy-confidence relationship. Qualitative investigations could illuminate psychological processes through which AI competence translates into confidence, particularly examining when supportive scaffolds transition into dependency-inducing crutches. Cross-cultural comparative studies would clarify whether observed relationships generalize across diverse educational systems. Gender should also be examined as a potential moderating variable using more balanced samples. Finally, studies should examine interactions between AI literacy, traditional language proficiency, and authentic communicative competence.

5. CONCLUSION

This study demonstrates that AI literacy significantly predicts foreign language confidence among university L2 learners, accounting for substantial variance in learners' psychological readiness for language production. The findings establish AI literacy as a foundational competence in contemporary language education, extending beyond technical proficiency to influence learners' self-efficacy, security, and sense of ownership in the target language. As generative AI technologies continue to transform educational landscapes, developing learners' capacity to strategically, critically, and ethically navigate AI-enhanced environments is essential for fostering authentic communicative competence. Future research should prioritize longitudinal designs to establish temporal precedence, randomized controlled trials to verify causal mechanisms, and cross-cultural comparative studies spanning Global South and Western contexts. At the policy level, universities are encouraged to embed structured AI literacy modules within formal language curricula, redesign teacher training programs to scaffold AI-mediated learner autonomy, and allocate targeted resources to ensure equitable AI tool access across diverse student populations.

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AUTHOR CONTRIBUTIONS STATEMENT

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C : Conceptualization
M : Methodology
So : Software
Va : Validation
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I : Investigation
R : Resources
D : Data Curation
O : Writing - Original Draft
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Vi : Visualization
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Fu : Funding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

Informed consent was obtained from all participants and their parents after explaining the study’s purpose, procedures, risks, and benefits, following ethical guidelines and institutional approval.

ETHICAL APPROVAL

The study protocol was approved by the Research Ethics Committee of the Faculty of Education, Al-Azhar University, Egypt (Ref. No. EDU-REC-2025-0251).

DATA AVAILABILITY

The data are available from the corresponding author, [MAN], upon reasonable request.

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