

AI literacy and academic engagement in higher education: the mediating role of foreign language anxiety

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ABSTRACT

The rapid integration of artificial intelligence (AI) in higher education has raised questions about how technological competencies influence student outcomes, particularly in foreign language learning where anxiety significantly affects performance. This study investigated whether foreign language anxiety (FLA) mediates the relationship between AI literacy (AIL) and academic engagement (AE) among 1,052 English as a foreign language (EFL) learners enrolled in foreign language programs at Al-Azhar University, Egypt. Participants completed three validated instruments: the artificial intelligence literacy scale (AILS), the short-form foreign language classroom anxiety scale (S-FLCAS), and the academic engagement scale (AES). Mediation analysis was conducted using PROCESS Model 4 with 5,000 bootstrap iterations to generate bias-corrected confidence intervals (CI). Correlation analyses revealed that AIL positively correlated with AE ($r=.31$, $p<.001$) and negatively with FLA ($r=-.35$, $p<.001$), while anxiety demonstrated a significant negative correlation with engagement ($r=-.21$, $p<.001$). Mediation analysis confirmed that FLA partially mediated the AIL–engagement relationship, with the indirect effect accounting for 12.2% of the total effect and the direct effect comprising the remaining 87.8%. These findings indicate that AIL enhances AE both directly and indirectly through anxiety reduction, suggesting that institutions should develop comprehensive AIL programs that address both technical skills and the affective dimensions of technology integration in language learning contexts.

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1. INTRODUCTION

The integration of artificial intelligence (AI) in higher education has expanded dramatically in recent years, with AI tools becoming increasingly prevalent across academic institutions worldwide. Research indicates that AI adoption in universities has accelerated significantly since 2021, with publications on AI in education increasing two- to threefold [1], [2]. AI tools are now used in universities across all continents, with particular emphasis on undergraduate education and language-learning contexts [2]. Contemporary students routinely employ AI applications such as ChatGPT, Grammarly, and Quillbot in their

academic work, with some studies documenting near-universal usage rates among surveyed populations [3], [4]. These AI-driven platforms facilitate individualized learning pathways, deliver instantaneous feedback, and offer tailored instructional materials that support diverse learning needs [5]–[7]. Despite widespread adoption, concerns regarding privacy, algorithmic bias, and student over-reliance persist [3], [8]. In Egypt specifically, national educational reform initiatives have prioritized technological integration across university curricula, positioning AI literacy (AIL) as a strategic competency for preparing graduates to meet evolving labor market demands, making the examination of AI's role in higher education particularly relevant within this regional context.

Within this rapidly evolving educational landscape, AIL has emerged as a fundamental competency in higher education, paralleling traditional literacies in its importance for students' academic and professional development. This literacy encompasses technical understanding, critical evaluation skills, and the ethical application of AI technologies across diverse disciplines [9]–[11]. Students with enhanced AIL demonstrate improved self-efficacy, higher-quality output, and greater academic engagement (AE), contributing to higher achievement and overall well-being [12]–[14]. Beyond academia, AI competencies have become critical differentiators in employability, with AI-proficient graduates more likely to secure positions aligned with their fields and report increased workplace productivity [15]. Furthermore, integrating AIL into curricula prepares students to address ethical considerations, including bias and privacy concerns, while fostering innovation and leadership capabilities essential for navigating an increasingly AI-driven professional landscape [16], [17].

At the intersection of AIL and engagement, students in foreign-language learning contexts are the primary stakeholders most directly affected by these educational transformations. University students learning English as a foreign language (EFL) constitute a particularly significant population, as they navigate the integration of AI-powered applications such as ChatGPT and other digital tools into their learning experiences [18], [19]. These learners experience multifaceted impacts on their engagement, motivation, and self-efficacy when interacting with AI technologies [20], [21]. Research demonstrates that EFL students encounter both opportunities—including personalized feedback—and challenges, such as increased anxiety, over-reliance on technology, and ethical concerns [22], [23]. Understanding how these students experience the intersection of AIL and AE is crucial for developing effective educational frameworks that address their unique needs and concerns.

The relationship between technology and foreign language anxiety (FLA) has undergone notable change in recent years. The intersection of technology and FLA grew with the rise of computer-assisted language learning in the 2000s and 2010s, although systematic research during this period remained limited [24], [25]. The mid-2010s marked a turning point as researchers began examining how educational technology could both alleviate and exacerbate FLA, with mixed results depending on implementation approaches [26]. However, the specific focus on AI-mediated language learning anxiety is a relatively recent phenomenon, gaining prominence only since 2019, as intelligent tutoring systems, chatbots, and generative AI tools have entered mainstream educational practice [27], [28]. Contemporary research now recognizes AI learning anxiety as a distinct construct that mediates learners' willingness to communicate and AE [19], while also acknowledging AI's dual potential to reduce traditional FLA through personalized feedback yet introduce novel anxieties related to technological complexity and AIL demands [29].

The theoretical pathway linking AIL to AE through reduced FLA operates through several interconnected psychological mechanisms. AIL equips learners with the competence and confidence to use AI tools effectively in language learning, fostering a sense of control and competence that directly increases their self-efficacy [19], [20]. This enhanced proficiency reduces uncertainty and fear of failure, key sources of FLA [29], [30]. As anxiety diminishes, students experience greater enjoyment, motivation, and willingness to communicate, essential components of AE [31], [32]. Empirical evidence confirms that FLA fully mediates this relationship, with AIL's effect channeled through reduced anxiety and enhanced self-efficacy [18], [33]. This pathway suggests that AI-enhanced learning environments addressing emotional well-being create more resilient and engaged learners.

Despite growing recognition that psychological factors mediate the relationship between AIL and engagement, research examining these mechanisms remains limited, particularly regarding negative emotions such as FLA, with no study to date having directly addressed this gap within an Arab or Egyptian higher education context where affective responses to AI-enhanced environments remain largely unexplored and where evidence-based strategies are urgently needed to guide curriculum designers and language educators in maximizing the benefits of AI tools while mitigating their psychological costs. While recent studies have explored positive mediators including self-efficacy and enjoyment in AI-assisted language learning contexts [20], [34], the role of anxiety as a mediating variable has received minimal attention. Systematic reviews indicate that research on AI's impact on affective factors is still in its infancy, with most studies focusing on technical or motivational aspects rather than complex psychological mediators [27], [35]. Notably, only

isolated studies have directly examined foreign language classroom anxiety (FLCA) as a mediator between AIL and communicative outcomes [19], leaving a substantial gap in understanding how anxiety specifically shapes this relationship. This scarcity contrasts sharply with extensive research on anxiety as an outcome variable in traditional language learning contexts [29], [36].

Given the identified gap in research examining anxiety as a mediating mechanism, this study investigates the relationship between AIL and AE among EFL university students, with particular attention to the mediating role of FLA. Specifically, this research seeks to: i) examine the direct relationship between AIL and AE; ii) assess the association between AIL and FLA; iii) evaluate the relationship between FLA and AE; and iv) determine whether FLA mediates the AIL –engagement relationship. By elucidating these relationships, this study contributes to theoretical understanding of how technological competencies interact with affective factors to shape learning outcomes, while offering practical insights for developing effective AI-enhanced educational interventions. This study addresses the following questions:

- What is the relationship between AIL and AE among EFL learners? (RQ1)
- What is the relationship between AIL and FLA? (RQ2)
- What is the relationship between FLA and AE? (RQ3)
- Does FLA mediate the relationship between AIL and AE? (RQ4)

2. METHOD

2.1. Research design

The study utilized a quantitative approach based on a cross sectional correlational framework, gathering all data at one time point to explore how AIL, FLA, and AE are interrelated. This design was deemed appropriate for testing the proposed mediation model without experimental manipulation.

2.2. Participants

The study comprised two samples: a main sample of 1,052 participants and a psychometric validation sample of 579 participants. Participants were recruited via convenience sampling from undergraduate students enrolled in foreign language programs at Al-Azhar University. The main sample consisted of students aged 18-23 years ($M=21.25$, $SD=1.61$) enrolled in foreign language programs at Al-Azhar University, Egypt. Table 1 outlines the demographic profiles of the participants in both samples, including gender distribution, target second language, language proficiency level, technology experience level, and primary purpose of AI use. Participants were drawn from three colleges in Cairo and Tafhna Al Ashraf. Participants were included if they: i) were currently enrolled as undergraduate students in a foreign language program at Al-Azhar University; ii) were aged 18–23 years; iii) had prior experience using at least one AI-based tool (e.g., ChatGPT, Grammarly, and Quillbot) in an academic context; and iv) provided voluntary informed consent. Students were excluded if they were enrolled in non-language programs or failed to complete 90% or more of the survey items.

2.3. Procedure

Data were collected online via Google Forms during the first semester of 2025–2026. All instruments were translated into Arabic using a rigorous translation–back-translation procedure by three expert translators to ensure accuracy. Participation was voluntary following informed consent. Data analysis was performed using SPSS 27 and AMOS 26.

Table 1. Demographic characteristics of study participants

Variable	Category	Psychometric sample (N=579)			Main sample (N=1052)		
		F	%	Cum. %	F	%	Cum. %
Gender	Male	121	20.9	20.9	423	40.2	40.2
	Female	458	79.1	100.0	629	59.8	100.0
Target second language	French	522	90.2	90.2	994	94.5	94.5
	English	57	9.3	100.0	58	5.5	100.0
Language proficiency level	Beginner	135	23.3	23.3	211	20.1	20.1
	Intermediate	389	67.2	90.5	714	67.9	87.9
	Advanced	55	9.5	100.0	127	12.1	100.0
Technology experience level	Beginner	143	24.7	24.7	182	17.3	17.3
	Intermediate	354	61.1	85.8	704	66.9	84.2
	Advanced	82	14.2	100.0	166	15.8	100.0
Purpose of AI use	Academic research	66	11.4	11.4	151	14.4	14.4
	Assignments and academic tasks	205	35.4	46.8	405	38.5	52.9
	Self-learning	252	43.5	90.3	407	38.7	91.5
	Entertainment	56	9.7	100.0	89	8.5	100.0

Note. F=frequency; %=percentage; Cum. %=cumulative percentage

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2.4. Measures

Artificial intelligence literacy scale (AILS), developed by Wang *et al.* [37], was employed to assess participants AIL across four dimensions: awareness, usage, evaluation, and ethics (understanding of ethical considerations in AI use). The instrument includes 12 items—three per dimension—rated on a 7-point Likert scale. Confirmatory factor analysis (CFA) demonstrated acceptable model fit: Chi-square or $\chi^2(50)=201.540$, $p<.001$, $\chi^2/df=4.031$, goodness of fit index (GFI)=.944, adjusted goodness of fit index (AGFI)=.912, comparative fit index (CFI)=.943, Tucker–Lewis index (TLI)=.924, root mean square error of approximation (RMSEA)=.072. Reliability analyses indicated good internal consistency for the total scale ($\omega=.882$, $\alpha=.881$) and adequate reliability for individual dimensions: awareness ($\omega=.714$, $\alpha=.712$), usage ($\omega=.717$, $\alpha=.700$), evaluation ($\omega=.755$, $\alpha=.754$), and ethics ($\omega=.715$, $\alpha=.718$). Short-form foreign language classroom anxiety scale (S-FLCAS) [38], an 8-item instrument assessing anxiety experienced in foreign language learning contexts. Participants responded on a 5-point Likert scale. CFA results supported the unidimensional structure of the scale: $\chi^2(19)=91.555$, $p<.001$, $\chi^2/df=4.819$, GFI=.961, AGFI=.926, CFI=.939, TLI=.911, RMSEA=.071. The scale demonstrated good reliability ($\omega=.785$, $\alpha=.775$, 95% CI [.744, .805]).

The academic engagement scale (AES), developed by Gaber *et al.* [39], was used to measure students' AE across three dimensions. The 33-item scale assesses cognitive engagement (mental investment and use of learning strategies), behavioral engagement (active participation and effort in academic activities), and emotional engagement (affective reactions and sense of belonging to the learning environment). Responses were measured using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). CFA indicated acceptable fit indices: $\chi^2(484)=1648.136$, $p<.001$, $\chi^2/df=3.405$, GFI=.841, AGFI=.815, CFI=.913, TLI=.905, RMSEA=.065. The scale exhibited excellent reliability for the total score ($\omega=.943$, $\alpha=.944$) and strong reliability for subscales: cognitive engagement ($\omega=.937$, $\alpha=.937$), behavioral engagement ($\omega=.908$, $\alpha=.906$), and emotional engagement ($\omega=.909$, $\alpha=.928$).

2.5. Data analysis

All statistical procedures were performed using SPSS 27 and AMOS 26. Preliminary analyses assessed common method bias using Harman's single-factor test, along with descriptive statistics and Pearson correlations to examine variable relationships. The mediation model was evaluated using the PROCESS Macro (Model 4), employing 5,000 bootstrap samples to produce bias-corrected confidence intervals (CI) for the indirect effects. Statistical significance of the mediation effect was determined by examining whether bootstrap CI excluded zero.

3. RESULTS

Preliminary analyses were conducted to evaluate data quality and check for common method bias. Harman's single-factor test showed that the first factor explained 21.765% of the variance, below the 50% threshold, suggesting no serious bias. Descriptive and correlation analyses were then used to assess variable relationships and the suitability of the mediation model. Descriptive statistics indicated that participants reported moderate to high levels of AIL ($M=58.59$, $SD=10.23$), with usage ($M=14.09$, $SD=3.43$) and ethics ($M=15.47$, $SD=3.10$) representing the highest and lowest dispersed dimensions, respectively. FLA scores were moderate ($M=24.57$, $SD=5.72$), while overall AE was above the scale midpoint ($M=132.96$, $SD=15.43$). Among the engagement subscales, emotional engagement recorded the highest mean ($M=45.72$, $SD=6.10$), followed by cognitive engagement ($M=44.22$, $SD=6.04$), and behavioral engagement ($M=42.90$, $SD=5.23$).

Pearson correlation analyses revealed significant relationships among all study variables, as seen in Table 2. AIL demonstrated a significant positive correlation with AE ($r=.312$, $p<.001$), supporting the study basic premise. More importantly, AIL showed a significant negative correlation with FLA ($r=-.35$, $p<.001$), while FLA showed a significant negative correlation with AE ($r=-.21$, $p<.001$), suggesting that anxiety may mediate these relationships. Among the AIL dimensions, awareness ($r=.81$, $p<.001$), usage ($r=.81$, $p<.001$), and evaluation ($r=.80$, $p<.001$) demonstrated the strongest associations with the total AIL score, while ethics showed a moderate correlation ($r=.62$, $p<.001$). Similarly, the three dimensions of AE—cognitive ($r=.88$, $p<.001$), behavioral ($r=.86$, $p<.001$), and emotional ($r=.88$, $p<.001$)—exhibited strong intercorrelations with the total engagement score, indicating coherent measurement of the construct.

The mediation model examining the indirect effect of AIL on AE through FLA was tested using PROCESS Model 4. As shown in Table 3, the total effect of AIL on AE was significant ($\beta=.4712$, $SE=.0442$, $p<.001$), with a standardized effect of .3124. When FLA was included as a mediator in the model, AIL significantly predicted FLA ($\beta=-.1944$, $SE=.0162$, $p<.001$), with a standardized effect of -.3476, explaining 12.08% of the variance in anxiety. Both AIL ($\beta=.4138$, $SE=.0469$, $p<.001$) and FLA ($\beta=-.2954$, $SE=.0839$, $p<.001$) significantly predicted AE when included simultaneously in the model. The indirect effect of AIL on

AE through FLA was statistically significant, as evidenced by bootstrap CI that did not include zero ($\beta=.0574$, $SE=.0184$), with a standardized indirect effect of .0381.

Table 2. Descriptive statistics and correlations among study variables

Variable	M	SD	1	2	3	4	5	6	7	8	9	10
1. Awareness	13.93	3.51	1									
2. Usage	14.09	3.43	.59**	1								
3. Evaluation	15.09	3.38	.53**	.54**	1							
4. Ethics	15.47	3.10	.29**	.30**	.34**	1						
5. AIL	58.59	10.23	.81**	.81**	.80**	.62**	1					
6. FLA	24.57	5.72	-.35**	-.29**	-.24**	-.16**	-.35**	1				
7. Cognitive engagement	44.22	6.04	.30**	.27**	.33**	.29**	.39**	-.22**	1			
8. Behavioral engagement	42.90	5.23	.18**	.15**	.23**	.16**	.23**	-.09**	.68**	1		
9. Emotional engagement	45.72	6.10	.13**	.13**	.18**	.26**	.23**	-.17**	.68**	.68**	1	
10. AE	132.96	15.43	.22**	.20**	.27**	.26**	.31**	-.21**	.88**	.86**	.88**	1

Note: M=mean; SD=standard deviation; ** $p<.001$

Table 3. Mediation model coefficients (N=1,052)

Outcome	Path	Unstandardized β	Standard error	t-value	p-value	95% CI	Standardized β
FLA	AIL $\rightarrow$ FLA	-.1944	.0162	-12.0112	<.001	[-.2261, -.1626]	-.3476
AE	AIL $\rightarrow$ AE	.4138	.0469	8.8227	<.001	[.3218, .5058]	.2764
	FLA $\rightarrow$ AE	-.2954	.0839	-3.5215	<.001	[-.4599, -.1308]	-.1095

Table 4 presents the decomposition of effects, revealing that the total effect of AIL on AE (.4712) comprises a direct effect (.4138, 87.8%) and an indirect effect through FLA (.0574, 12.2%). These findings confirm partial mediation, wherein FLA accounts for a modest but statistically significant portion of the relationship. The persistence of a substantial direct effect suggests that AIL influences AE through multiple pathways beyond anxiety reduction, while the significant indirect effect confirms that anxiety plays a meaningful mediating role in this relationship.

The mediation relationships are visually summarized in Figure 1, which illustrates the direct and indirect pathways through which AIL influences AE. As depicted in the model, AIL exerts both a direct effect on AE ($\beta=.274$, $p<.001$) and an indirect effect mediated through FLA ($\beta=.038$). The negative pathway from AIL to FLA ($\beta=-.348$, $p<.001$) combined with the negative pathway from FLA to AE ($\beta=-.110$, $p<.001$) produces a positive indirect effect, suggesting that higher AIL reduces anxiety, which in turn enhances AE. The pattern of effects supports a partial mediation model, wherein FLA accounts for 12.2% of the total relationship between AIL and AE.

Table 4. Decomposition of total, direct, and indirect effects

Effect type	Unstandardized effect	Standardized effect	Bootstrap SE	Bootstrap 95% CI	% of total effect
Total effect	.4712	.3124	.0442	[.3845, .5580]	100.0
Direct effect	.4138	.2744	.0469	[.3218, .5058]	87.8
Indirect effect (via FLA)	.0574	.0381	.0184	[.0214, .0940]	12.2

Note: SE=standard error.

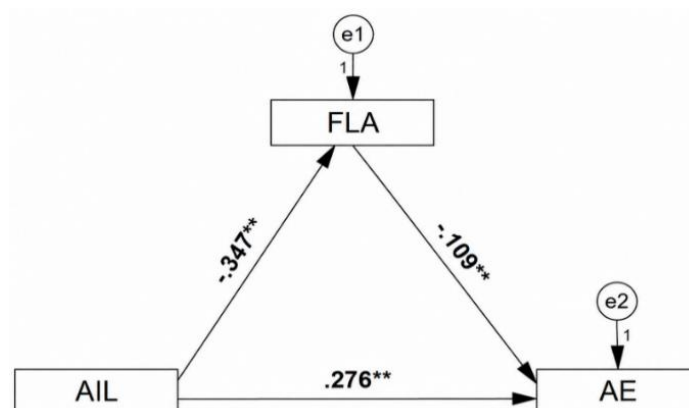


Figure 1. Mediation model of AIL, FLA, and AE

4. DISCUSSION

The findings reveal that AIL significantly enhances AE among foreign language learners, with FLA partially mediating this relationship. AIL demonstrated a moderate positive correlation with AE and a moderate negative correlation with anxiety, while anxiety showed a significant negative relationship with engagement. The mediation analysis confirmed that anxiety accounts for a modest but meaningful portion of the total effect, while the majority operates through direct pathways. This pattern suggests that AIL influences engagement through multiple mechanisms, wherein anxiety reduction represents one pathway while enhanced competence and increased confidence in navigating AI-enhanced environments represent others. These results provide empirical support for the theoretical proposition that technological competencies operate through both affective and cognitive channels to influence learning outcomes, with technological proficiency alleviating apprehension in foreign-language contexts while simultaneously promoting deeper cognitive, behavioral, and emotional investment in academic activities.

At the dimensional level, awareness, usage, and evaluation showed stronger correlations with engagement and anxiety than ethics. This pattern may be explained by the abstract nature of ethical reasoning compared to the practical, task-oriented character of the other dimensions. While awareness, usage, and evaluation competencies are enacted through direct, concrete interactions with AI tools that immediately reduce uncertainty and build confidence, ethical understanding remains conceptually distant from students' routine academic experiences, thereby attenuating its proximal influence on affective and engagement outcomes. From a self-determination theory perspective, practical AI skills more readily satisfy students' needs for competence and autonomy than ethical literacy, limiting the latter's immediate motivational impact.

These results align with emerging research documenting AIL's positive effects on student outcomes. The finding that AIL enhances self-efficacy and reduces uncertainty parallels observations by Zhang *et al.* [19] and Fan and Zhang [20], who demonstrated that technological competence fosters control and confidence in AI-assisted learning environments. The anxiety reduction mechanism corroborates previous works [29], [30], which identified technological complexity as a key source of FLA. Furthermore, the partial mediation model supports the previous findings [18], [33], who documented that affective factors mediate the effects of AIL on engagement. The positive correlation between AIL and AE ($r=.31$) is consistent with several findings [12], [13], which reported similar relationships between AI competencies and learning outcomes. The negative relationship between AIL and anxiety aligns with previous research [24], [25], who found that technological proficiency reduces learning anxiety. Additionally, the mediating role of anxiety is supported by several studies [31], [32], [35], who demonstrated that emotional factors mediate technology-learning relationships. However, the relatively modest proportion of variance explained through anxiety suggests that positive mediators such as enjoyment and motivation [21]–[23], [34], may operate alongside anxiety reduction in shaping engagement outcomes.

These findings carry significant implications for curriculum design and pedagogical practice in higher education. Institutions should integrate AIL as a standalone or embedded component within foreign language curricula, incorporating structured modules on navigating AI tools, critically evaluating AI outputs, and reflecting on the ethical use of AI. Policymakers should consider mandating AIL training within national higher education frameworks, while language educators should be equipped through professional development programs to scaffold AI tool adoption in ways that explicitly address learners' affective responses and reduce technology-related anxiety. Educators must recognize that reducing FLA through AI proficiency training is a viable strategy to enhance student engagement. Professional development initiatives should equip instructors with strategies to scaffold AI tool adoption while attending to learners' affective responses. Additionally, course designers should create supportive learning environments in which students can gradually develop AI competencies without feeling overwhelmed by technological anxiety. Given that direct pathways account for most of the relationship, interventions should also target other mechanisms, such as enhancing self-efficacy, using personalized feedback, and developing metacognitive strategies, to maximize the benefits of AIL for AE.

The findings have critical ramifications for the future of AI-integrated education. First, they suggest that investing in AIL development yields dual benefits: direct enhancement of engagement and indirect reduction of anxiety, creating more resilient learners capable of adapting to rapidly evolving technological landscapes. Second, as AI tools become ubiquitous in academic settings, institutions that neglect students' affective responses risk widening achievement gaps between technologically confident and anxious learners. Third, the partial mediation model indicates that simply providing AI tools is insufficient; comprehensive support addressing both competence and emotional well-being is essential. Looking forward, these insights will inform the design of adaptive AI systems that respond to learners' anxiety levels, guide policy decisions regarding mandatory AIL curricula, and shape teacher training programs that balance technological skills with socio-emotional support strategies, ultimately preparing graduates for workplaces where AI collaboration is standard practice.

Several limitations warrant consideration. First, the cross-sectional design precludes causal inferences, as the direction of relationships among AIL, anxiety, and AE cannot be definitively established. Second, the use of convenience sampling from a single institution represents a notable methodological limitation, as findings may not generalize to students from diverse institutional, cultural, or linguistic backgrounds; future studies should employ probability sampling across multiple institutions to enhance external validity. Third, the study focused exclusively on FLA as a mediator, overlooking other potentially important psychological mechanisms such as self-efficacy, enjoyment, and intrinsic motivation that may operate alongside or independently of anxiety in shaping the AIL –engagement relationship. Finally, variations in AI tool types, frequency of use, and instructional approaches were not accounted for, which may have introduced unmeasured heterogeneity into the findings.

Future investigations should adopt longitudinal or experimental approaches to establish causality and to monitor how AIL shapes anxiety and engagement over time. Researchers should explore additional mediators such as enjoyment, self-efficacy, and intrinsic motivation to develop more comprehensive explanatory models. Cross-cultural studies across diverse educational contexts would enhance generalizability of the findings. Examining moderating variables, including AI tool types, instructional approaches, and prior technology experience, would provide nuanced insights into boundary conditions. Finally, mixed-methods approaches integrating qualitative and behavioral data would offer richer understanding of underlying mechanisms.

5. CONCLUSION

This study demonstrated that AIL significantly enhances AE among EFL university students, with FLA serving as a meaningful yet partial mediator. AIL positively correlated with AE and negatively with FLA, while anxiety negatively correlated with engagement. The mediation analysis confirmed that FLA accounts for 12.2% of the total effect, with the remaining 87.8% operating through direct pathways, indicating that multiple psychological mechanisms simultaneously link technological competence to learning outcomes. These findings highlight the importance of integrating AIL programs into foreign language curricula as both technical and affective interventions. Future research should adopt longitudinal designs, explore additional mediators such as self-efficacy and enjoyment, and conduct cross-cultural studies to broaden generalizability.

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AUTHOR CONTRIBUTIONS STATEMENT

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C : Conceptualization

M : Methodology

So : Software

Va : Validation

Fo : Formal analysis

I : Investigation

R : Resources

D : Data Curation

O : Writing - Original Draft

E : Writing - Review & Editing

Vi : Visualization

Su : Supervision

P : Project administration

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-2024-0587).

DATA AVAILABILITY

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

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