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Exploring Augmented Reality (AR) Literacy among Iranian EFL Teachers: A Mixed-Methods Study

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ABSTRACT

Augmented reality (AR) has emerged as an important pedagogical tool, attracting the attention of educators and researchers over the past decade. Despite this growing interest, its application within technology-enhanced language teaching and learning remains underexplored. The present study investigated the AR literacy of Iranian EFL teachers using a mixed-methods approach. A sample of 300 EFL teachers, randomly selected from Iranian public high schools (n=100), private (non-profit) schools (n=100), and private language institutes (n=100), completed an augmented reality literacy questionnaire. Additionally, a portion of participants from each group (n=30) participated in semi-structured interviews developed by the researchers. A two-way MANOVA analysis indicated that teachers from private language institutes exhibited the highest mean scores across all four AR literacy domains (Computer skills, AR practice, experience, and perception), followed by those from public and private high schools. No significant gender-based differences were observed in teachers' awareness of AR components. The interview results revealed that Iranian EFL teachers rarely integrate AR into their classroom practices, often equating it narrowly with basic computer skills such as internet use, video playback, and online search. Based on the findings, utilization of AR into EFL context is suggested, as this integration holds potential for language educators and material developers to create more engaging and dynamic learning tasks.

***KEYWORDS*:** Augmented reality; Iranian EFL teachers; Mixed methods study; Technology-enhanced language teaching

1. Introduction

Technological advancements have significantly influenced educational practices, inevitably reshaping teaching and learning design and methodologies across disciplines. The process of change (tech integration) is so drastic that the contemporary learners are characterized as "digital natives" whose educational experiences are shaped by technological innovations (Singhal, 2012). Among these emerging technologies, augmented reality (AR) particularly, has emerged as an effective tool, though its incorporation into technology-enhanced language teaching and learning remains underexplored. There are a limited number or reports available, suggesting AR advantage over traditional two-dimensional methods by delivering three-dimensional learning experiences to the learners. This improvement can affect the traditional context of learning by providing more realistic and authentic experiences for learners potentially yielding more effective and durable learning outcomes (Chang et al., 2014; Parmaxi & Demetriou, 2020).

In the field of foreign language teaching and learning, application of AR tools is gaining momentum, partly as a there is a pressing demand to accommodate the preferences of the millennial generation (Taskiran, 2019). Using AR phenomena, through mobile-based applications, has been reportedly effective, especially in enhancing vocabulary acquisition, supporting reading comprehension and facilitating speaking practice (Bronack, 2011). Unlike fully immersive Virtual Reality (VR), AR enables users to interact with both physical surroundings and superimposed virtual elements, often through head-mounted

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displays or mobile interfaces (Simonova & Kolesnichenko, 2022). For instance, AR can contextualize learning by overlaying translations onto real-world objects, enhancing engagement and retention. This interactivity distinguishes AR from conventional interfaces, fostering a more immersive experience (Billinghurst & Kato, 2002).

Despite the potential of AR to enhance EFL teaching, there is a lack of systematic research on Iranian EFL teachers' AR literacy, particularly across diverse educational settings. Existing literature highlights the need for studies that examine teachers' readiness to adopt emerging technologies, especially in contexts where traditional teaching methods dominate (Karacan & Akoglu, 2021; Parmaxi & Demetriou, 2020).

Given the challenges identified in technology integration in Iranian education, such as lack of confidence and competence (Dehghan, 2025; Jahanban-Isfahlan et al., 2017), it is imperative to understand how well EFL teachers are prepared to use AR and what factors influence their literacy levels. In this line, the current study is an attempt to address Iranian EFL teachers' AR literacy in the context of foreign language teaching and learning. By examining this issue, the research seeks to contribute to the limited but growing discourse on AR's role in EFL education.

2. Literature review

Generally, AR refers to a technology that overlays digital elements, such as visuals or texts, into the real world, creating interactive experiences through devices like smartphones or tablets (Azuma, 1997). In contrast to VR, which fully immerses users in a digital environment, AR enriches the physical world with context-sensitive, interactive learning possibilities (Milgram & Kishino, 1994).

Amiri (2025) state that augmented reality (AR) technology, which is relatively new in the field of technological knowledge (TK), can be a powerful tool for teacher education that integrates with the technological pedagogical content knowledge (TPACK) framework. This tool allows for deeper and more active learning experiences. In addition, according to Schmid (2024), AR improves and changes the conventional wisdom about TPACK by forming new connections among the aforementioned three domains of expertise: content knowledge (CK), pedagogical knowledge (PK), and TK. To keep the quality of education relevant to technological progress in this age of rapid technological improvement, new approaches to learning are necessary (Holopainen, 2022; Mu & Wang, 2022). Augmented reality is a technological advancement that has the potential to broaden the breadth of education, improve students' learning experiences, and deepen their understanding of subject matter (Jumadi, 2021). Teachers need to be flexible to meet the changing demands of modern classrooms, since students' learning styles have evolved to incorporate new forms of technology (Nisak, 2023; Syahriani & Hasruddin, 2024). This adaptability not only enhances student engagement but also fosters critical thinking and collaboration among peers. By embracing these innovations, educators can create more inclusive environments that cater to diverse learning needs.

In educational settings, AR supports hands-on learning by making abstract concepts tangible, such as 3D models in science or dynamic narratives in language instruction. By enabling students to experience academic phenomena in real-world environments, AR has demonstrated significant pedagogical potential. For instance, Klopfer and Squire (2008) highlighted AR's capacity to simulate scientific processes, while Liu et al. (2007) showcased its application in visualizing a digital solar system or the process of photosynthesis on classroom surfaces. Kerawalla (2006) further noted that AR motivates students to actively manipulate virtual objects, fostering engagement. However, Bronack (2011) emphasized that the value of AR lies not in its technological complexity but in its ability to facilitate educational outcomes. For educators, researchers, and curriculum designers, conceptualizing AR as a pedagogical approach—rather than a mere technological tool—may yield more meaningful insights into its classroom applications.

The literature review on augmented reality (AR) identifies three key theoretical frameworks relevant to education and language teaching. Constructivist learning theory posits that learners build knowledge through active engagement with their environment, supported by AR's interactive experiences like manipulating digital objects (Piaget, 1970; Vygotsky, 1978; Wu, 2013). Situated learning theory emphasizes learning through authentic, context-specific activities, facilitated by AR's real-world simulations, such as virtual language exchanges (Lave & Wenger, 1991; Bacca, 2014). The Technology Acceptance Model (TAM) suggests technology adoption depends on perceived usefulness (PU) and ease of use, with AR's educational benefits PU and user-friendly interfaces shaping its integration (Davis, 1989; Amores-Valencia et al., 2025). For teachers, AR literacy involves understanding how to leverage these tools to foster student-centered learning, though limited training may hinder implementation (Rahimi & Pourshahbaz, 2019).

AR also fits effectively into the TPACK framework by enhancing EFL teachers' technology integration. Developed by Mishra and Koehler (2006), The TPACK framework integrates CK, PK, and TK to guide teachers in incorporating technology into their practice. TPACK intersections; Technological Content Knowledge (TCK), Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK) enable teachers to align technology with content and pedagogy (Koehler, 2013).

In EFL teacher education, TPACK supports the integration of technologies to enhance language learning, making it a critical lens for examining AR literacy (Tseng, 2019). TCK enables teachers to use AR to represent language content, such as visualizing grammar structures through 3D models (Godwin-Jones, 2016). TPK allows teachers to design AR-based pedagogical strategies, like virtual role-plays to practice speaking, fostering engagement (Dunleavy & Dede, 2014). Full TPACK integration occurs when teachers combine CK (e.g., teaching vocabulary), PK (e.g., communicative methods), and TK (e.g., AR apps) to create immersive EFL lessons, such as AR-supported writing tasks (Amores-Valencia et al., 2025). AR thus enhances engagement and contextual learning, aligning with TPACK's emphasis on effective technology use (Wu, 2013).

The TPACK integration has been reportedly effective, as TK requires proficiency with AR tools, however teachers often perceive AR as complex, necessitating targeted training to build confidence (Kaplan-Rakowski et al., 2023). Full TPACK integration, where AR competencies enhance teaching quality, is critical, with AlSuwaihel (2024) demonstrating that such skills predict effective EFL instruction. However, Iranian EFL teachers face barriers, including limited AR infrastructure and professional development, mirroring challenges in other developing countries (Nikimaleki & Rahimi, 2022; Annamalai, 2023). Opportunities arise from Iran's collectivist classroom culture, which aligns with AR's collaborative potential (Annamalai, 2023; Nikimaleki & Rahimi, 2022), and from fostering positive perceptions of AR's pedagogical value through TPACK-based training (Kaplan-Rakowski et al., 2023). Despite these insights, the scarcity of research on Iranian EFL teachers' AR literacy within TPACK underscores the need for this study, which explores how TPACK can guide AR integration to enhance language instruction in Iran.

Despite these efforts, within the domain of EFL instruction, research on AR implementation still remains limited (Akçayır & Akçayır, 2017; Ibáñez et al., 2011; Scrivner, 2016; Silva, 2013; Solak & Cakir, 2015). Hsu (2017) found that self-directed AR approaches can bolster second language (L2) learning, while Godwin-Jones (2016) identified two AR variants, marker-based AR, where hardcoded images trigger actions, and place-based AR, which uses mobile sensors like GPS to generate feedback, as particularly effective for language and vocabulary acquisition. Competitive AR gaming has also been shown to enhance both learning attitudes and performance (Vazquez, 2017; Wu, 2018). Additionally, AR has supported specific linguistic skills, such as Japanese orthography (Yang & Mei, 2018), and facilitated L2 pragmatic learning through mobile-based film episodes, with learners reporting satisfaction with the contextual information provided (Sydorenko, 2019). Conceptual tools like the repertory grid, a matrix for organizing knowledge, have further complemented AR's pedagogical applications (Rozenszajn & Yarden, 2015).

AR learning environments have proven highly motivating and engaging for EFL learners and teachers alike (Amiri & Nezakatgoo, 2019; Gayevska & Kravtsov, 2022; Taskiran, 2019). Zhang (2020) noted that AR enables teachers to design innovative, collaborative tasks, fostering social connectivity and networked language learning where students can express ideas and co-create meaning. Other studies highlight AR's alignment with learners' and teachers' attitudes, knowledge, and skills (Fan, 2020; Parmaxi & Demetriou, 2020). Beyond EFL, AR has addressed diverse educational needs, such as improving reading and spelling for children with attention deficit hyperactivity disorder (Tosto, 2021) and enhancing Persian language learning for non-native speakers by increasing engagement and enjoyment (Mozaffari & Hamidi, 2022). While some studies report significant impacts on EFL achievement with moderate effects on motivation (Cai, 2022; Karacan & Akoglu, 2021), others underscore AR's role in elevating the quality of foreign language courses (Amiri & Nezakatgoo, 2019; Simonova & Kolesnichenko, 2022).

The literature reflects a growing focus on AR in L2 classrooms, with applications ranging from vocabulary instruction (Barreira et al., 2012; Godwin-Jones, 2016; Solak & Cakir, 2015) and motivation strategies for Turkish EFL learners (Taskiran, 2019) to assessment practices (Salmon & Nyhan, 2013) and futuristic EFL contexts in Japan (Gayevska & Kravtsov, 2022). Specific studies have validated AR tools, such as questionnaires for assessing teacher awareness (Amiri & Nezakatgoo, 2019), and explored mobile-based AR for teaching visual language items (Sydorenko, 2019). Despite this breadth, systematic research on EFL teachers' AR literacy, particularly in the Iranian context, remains scarce (Fan, 2020; Ibáñez et al., 2011; Karacan & Akoglu, 2021; Parmaxi & Demetriou, 2020; Scrivner et al., 2016; Vazquez, 2017; Yang, 2011; Yang & Mei, 2018). Existing studies consistently call for deeper investigations into AR's unique affordances compared to other educational technologies, emphasizing the need for comprehensive analyses to fully realize its potential in language learning environments.

Based on the review of related literature, the present study attempted to investigate Iranian EFL teachers' augmented reality literacy, utilizing a mixed-methods study design, answering the following questions:

1. To what extent are Iranian EFL teachers in state high schools, private high schools, and private language institutes aware of components of augmented reality?
2. To what extent statistically significant difference is found between Iranian male and female EFL teachers in terms of their awareness of AR components?
3. To what extent do Iranian EFL teachers in state high schools, private high schools, and private language institutes make use of AR in their classes based on their claims?

3. Methodology

3.1. Participants

In this study, 300 EFL teachers practicing in public and private schools in different cities in Iran such as Tehran, Shiraz, Isfahan, Rasht, Mashhad, Tabriz, and Ahvaz were selected through random sampling to participate in the quantitative data-gathering phase. The sample size was determined using the Krejcie-Morgan Table (1970), Based on an estimated population of approximately 10,000 EFL teachers across public high schools, private (non-profit) schools, and private language institutes in Iran, the Krejcie-Morgan Table recommended a sample size of 370 for a 95% confidence level and a 5% margin of error. However, due to practical constraints, including resource limitations and anticipated response rates, a sample of 300 was deemed sufficient to achieve adequate statistical power while maintaining representativeness (Bukhari, 2021). The sample comprised teachers from three educational contexts: public high schools (n=100), private (non-profit) schools (n=100), and private language institutes (n=100), with a gender distribution of 132 males and 168 females, aged 22 to 50.

All participants held degrees in English-related fields, including Teaching English as a Foreign Language (TEFL), English translation, English literature, or, in some cases, linguistics. To gather quantitative data, participants completed the AR literacy questionnaire (Amiri & Nezakatgoo, 2019). For the qualitative phase, informed by qualitative research guidelines (Creswell & Plano Clark, 2023), 10% of each group (n=30 total) was randomly selected for semi-structured interviews, designed based on a comprehensive literature review and aligned with the questionnaire's constructs.

3.2. Instrumentation

For data collection researchers utilized two instruments: a questionnaire and semi-structured interviews. The quantitative phase employed an adopted version of the Augmented Reality (AR) Questionnaire for Applied Linguistics Instructors (Amiri & Nezakatgoo, 2019), designed to assess Iranian EFL teachers' AR literacy across four components: Computer Skills, AR Practices, AR Experience, and AR Perceptions. The questionnaire demonstrated strong reliability, with a Cronbach's alpha of .813 overall and component-specific values of .894 (Computer Skills), .781 (AR Practices), .805 (AR Experience), and .863 (AR Perceptions). As reported by Amiri and Nezakatgoo (2019), exploratory factor analysis confirmed the instrument's construct validity.

Following Dörnyei and Taguchi (2009) to incorporate expert consultation and participant insights along with complementing the questionnaire and enrich the data, semi-structured interviews were conducted with 30 teachers (10 from each group). Cheron et al. (2022) argues that the use of interview guide is essential for the researcher, that is, the researcher attends to a variety of issues and at the same time to achieve the desired objectives. The interview guide, comprising six items, was developed through a thorough literature review: the interview items explored participants' awareness of AR principles (AlSuwaihel, 2024; Amiri & Nezakatgoo, 2019; Chen, 2025; Wu, 2018), their use of AR in classrooms (Azuma, 1997; Zhang et al., 2020), specific techniques employed (Parmaxi & Demetriou, 2020; Yang & Mei, 2018), computer skills applied in teaching (AlSuwaihel, 2024; Tosto, 2021), and mobile applications relevant to instruction (Amiri, 2025; Nikimaleki & Rahimi, 2022; Syahriani & Hasruddin, 2024). The interview protocol along with in-text citations appears in appendix B.

To ensure dependability, the researcher minimized bias by fostering an open dialogue, avoiding leading questions, and granting interviewees freedom of expression, as advised by Creswell (2021). Following Corbin and Strauss (2015), the interview items were re-examined by three Ph.D. holders in TEFL with expertise in information technology to ensure its appropriateness of content and language (credibility): According to Cutcliffe and McKenna (1999), the enhancement of authenticity is bound to the results' accuracy. Therefore, the researchers used a range of techniques to increase the trustworthiness of the findings: First, the researchers, who acted as the interviewers, relied on measures to minimize biases and limitations likely to affect their decision-making to assure the dependability (i.e., reliability) of the interviews (Dörnyei, 2007). In this respect, and in line with Creswell (2021), the respondents were given the opportunity to express themselves freely, and the researchers welcomed all of the responses and points of view that were offered. Additionally, the researchers made an effort to be consistent in scoring and weighting the interviewees' opinions. Then, consistency in the information-gathering process was taken into account as a sign of reliability or consistency (Payne, 2025). Moreover, Cohen's kappa coefficient intercoder reliability index was estimated as κ=0.87, which represented an almost perfect agreement (Creswell, 2021).

Second, the participants were given the final summary of the findings so that they could scrutinize the findings and see if the information actually comes from their perceptions. Third, the researchers checked different aspects of the phenomenon under investigation frequently and enlisted significant points and finalized them through the cooperation of a peer debriefer, other than the researcher and coder, to increase the validity of the research. Fourth, the researchers asked an external independent editor, experienced in educational research and applied linguistics, to review the entire study and scrutinize the whole research process. Having checked the data collection procedure, the transcripts, and coded data, the external independent editor finally confirmed that the data collection procedure was genuine and the coding system was accurate. This way the interview guide's content validity and credibility were confirmed through expert judgment validity criteria (Creswell & Plano Clark, 2023).

3.3. Data collection procedure

The data collection process unfolded in two phases. First, the AR literacy questionnaire was distributed to the 300 participants across the three groups. To facilitate access, the questionnaire was imported to Google Forms, and teachers were invited to participate via social media platforms and messaging applications, including WhatsApp and Telegram.

Following the quantitative phase, the qualitative interviews were conducted with 30 randomly selected teachers. Participants were contacted via telephone to schedule interviews, with their preferences for online or face-to-face formats accommodated. The interview guide was sent in advance through their preferred application. During each session, the researcher posed questions in English, though Persian was used in rare instances to mitigate language barriers and ensure participants could express their views fully and interviewees' consent were accumulated. Next, interviews were audio-recorded, transcribed, and reviewed with participants to clarify ambiguities and confirm accuracy. A brief summary of each interviewee's responses was presented at the session's conclusion to verify their perspectives, ensuring data integrity for subsequent analysis.

4. Results

4.1. Quantitative data analysis

To examine differences in AR literacy among Iranian EFL teachers, a Two-Way MANOVA was conducted, comparing group means across four components of the AR questionnaire: Computer Skills, AR Experience, AR Practices, and AR Perceptions. The analysis assessed variations by teaching context (public high schools, private high schools, private language institutes) and gender. Prior to interpreting the results, the MANOVA assumptions of normality, homogeneity of variances, and homogeneity of covariance matrices were evaluated.

First and foremost, the skewness and kurtosis indices of normality were estimated. Since all indices were within the ranges of ±2 (Bachman, 2005), it was concluded that the assumption of normality was retained. Moreover, Two-Way MANOVA requires groups' enjoy homogeneous variances on four dependent variables of Computer skills, AR Experience, AR Practice, and AR Perceptions. Homogeneity of variances was tested using Levene's test, which indicated violations for all four components (Table 1): Computer Skills ($F(5, 294) = 2.35$, $p < .05$), AR Experience ($F(5, 294) = 3.27$, $p < .05$), AR Practices ($F(5, 294) = 2.30$, $p < .05$), and AR Perceptions ($F(5, 294) = 3.31$, $p < .05$). There is no need to worry about the violation of the assumption of homogeneity of variances. Following Tabachnick and Fidell (2014), such violations can be addressed by adopting a more stringent alpha level (e.g., $\alpha = .01$ instead of .05) or transforming deviated scores, though interpretation would then apply to transformed data. To maintain robustness, this study used untransformed variables with an alpha level of .01 for all MANOVA results, as reported in Tables 3, 5, and 6.

Table 1.

Levene's Test of Equality of Error Variances

		Levene Statistic	df1	df2	Sig.
Computer Skill	Based on Mean	2.631	5	294	.024
	Based on Median	2.350	5	294	.041
	Based on the Median and with adjusted df	2.350	5	275.006	.041
	Based on trimmed mean	2.710	5	294	.021
AR-Experience	Based on Mean	4.241	5	294	.001
	Based on Median	3.274	5	294	.007
	Based on the Median and with adjusted df	3.274	5	263.124	.007
	Based on trimmed mean	4.261	5	294	.001
AR-Practice	Based on Mean	2.718	5	294	.020
	Based on Median	2.300	5	294	.045
	Based on the Median and with adjusted df	2.300	5	237.587	.046
	Based on trimmed mean	2.607	5	294	.025
AR-Perception	Based on Mean	3.834	5	294	.002
	Based on Median	3.331	5	294	.006
	Based on the Median and with adjusted df	3.331	5	266.734	.006
	Based on trimmed mean	3.852	5	294	.002

Two-Way MANOVA, besides the assumption of homogeneity of variance, require the differences between any two dependent variables have homogenous variances; i.e. the assumption of homogeneity of covariance matrices as tested using Box's M test (see Table 2). The results ($M = 117.98$, $p < .001$) indicated that the assumption of homogeneity of covariance matrices was violated.

Table 2.

Box's Test of Equality of Covariance Matrices

Box's M	117.981
F	2.277
df1	50
df2	143237.041
Sig.	.000

As recommended in the literature (Li & Chen, 2019, as cited in Aryadoust & Raquel, 2019), Pillai's Trace was employed for its robustness in such cases, ensuring reliable interpretation of the MANOVA results (see Table 3). This approach mitigates

concerns about the violation, aligning with best practices for handling non-homogeneous covariance matrices (Field, 2024; Pallant, 2016; Tabachnick & Fidell, 2014).

Table 3.

Multivariate Tests for Components of Augmented Reality by Groups by Gender

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	.929	955.273	4	291	.000	.929
	Wilks' Lambda	.071	955.273	4	291	.000	.929
	Hotelling's Trace	13.131	955.273	4	291	.000	.929
	Roy's Largest Root	13.131	955.273	4	291	.000	.929
Group	Pillai's Trace	.317	13.773	8	584	.000	.159
	Wilks' Lambda	.688	14.986	8	582	.000	.171
	Hotelling's Trace	.447	16.209	8	580	.000	.183
	Roy's Largest Root	.430	31.406	4	292	.000	.301
Gender	Pillai's Trace	.011	.827	4	291	.509	.011
	Wilks' Lambda	.989	.827	4	291	.509	.011
	Hotelling's Trace	.011	.827	4	291	.509	.011
	Roy's Largest Root	.011	.827	4	291	.509	.011
Group * Gender	Pillai's Trace	.023	.834	8	584	.573	.011
	Wilks' Lambda	.977	.833	8	582	.573	.011
	Hotelling's Trace	.023	.833	8	580.000	.574	.011
	Roy's Largest Root	.020	1.443	4	292.000	.220	.019

The Two-Way MANOVA results (Table 3), revealed significant differences in overall AR literacy across teaching contexts ($F(8, 584) = 13.77$, $p < .01$, partial $\eta^2 = .159$), indicating a large effect size (Gray & Kinnear, 2012; Pallant, 2016). Partial eta squared values were interpreted as follows: .01 (weak), .06 (moderate), and .14 (large). Consequently, the first null hypothesis, positing no difference between groups, was rejected. Conversely, no significant gender differences were observed in overall AR literacy ($F(4, 291) = .827$, $p > .01$, partial $\eta^2 = .011$, weak effect size), supporting the second null hypothesis. Similarly, no significant interaction between gender and group was found ($F(8, 857) = .827$, $p > .01$, partial $\eta^2 = .011$, weak effect size). Detailed component-level findings are elaborated in Tables 4, 5, and 6.

Table 4.

Descriptive Statistics for Components of Augmented Reality by Group

Dependent Variable	Group	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Computer Skill	Language Institute	2.839	.085	2.672	3.006
	Public	2.484	.084	2.318	2.650
	Private	1.815	.084	1.650	1.980
AR-Experience	Language Institute	2.857	.086	2.687	3.026
	Public	2.463	.086	2.295	2.632
	Private	1.805	.085	1.637	1.973
AR-Practice	Language Institute	2.964	.086	2.793	3.134
	Public	2.362	.086	2.193	2.531
	Private	1.850	.086	1.682	2.019
AR-Perception	Language Institute	2.879	.081	2.719	3.039
	Public	2.404	.081	2.245	2.563
	Private	1.855	.081	1.696	2.013

Table 4 presents the mean scores of EFL teachers across the three groups on the four AR literacy components. Teachers from private language institutes consistently achieved the highest means, followed by those from public high schools and private high schools. Between-subjects effects (Table 5) confirmed significant differences across groups for all components.

Table 5.

Tests of Between-Subjects Effects Components of Augmented Reality by Group by Gender

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Group	Computer Skill	53.292	2	26.646	38.009	.000	.205
	AR-Experience	55.653	2	27.827	38.477	.000	.207
	AR-Practice	61.100	2	30.550	41.937	.000	.222
	AR-Perception	51.673	2	25.837	40.115	.000	.214
Gender	Computer Skill	.903	1	.903	1.287	.257	.004
	AR-Experience	.116	1	.116	.161	.688	.001
	AR-Practice	.324	1	.324	.445	.505	.002
	AR-Perception	.049	1	.049	.076	.783	.001
Group * Gender	Computer Skill	.821	2	.411	.586	.557	.004
	AR-Experience	.178	2	.089	.123	.884	.001
	AR-Practice	2.073	2	1.037	1.423	.243	.010
	AR-Perception	.548	2	.274	.426	.654	.003
Error	Computer Skill	206.105	294	.701			
	AR-Experience	212.620	294	.723			
	AR-Practice	214.174	294	.728			
	AR-Perception	189.353	294	.644			
Total	Computer Skill	1950.583	300				
	AR-Experience	1957.688	300				
	AR-Practice	2003.625	300				
	AR-Perception	1941.109	300				

Post-hoc Scheffé tests (Table 6) further indicated that language institute teachers scored significantly higher than both public and private high school teachers on all AR sub-skills. Additionally, public high school teachers outperformed private high school teachers on these sub-skills, highlighting contextual disparities in AR literacy.

Table 6.

Post-Hoc Scheffe's Tests; Components of Augmented Reality by Group

Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Computer Skill	Language Institute	Public School	.37*	.118	.009	.08	.66
		Private School	1.02*	.118	.000	.73	1.31
	Public School	Private School	.66*	.118	.000	.36	.95
AR-Experience	Language Institute	Public School	.39*	.120	.006	.09	.68
		Private School	1.05*	.120	.000	.75	1.34
	Public School	Private School	.66*	.120	.000	.37	.96
AR-Practice	Language Institute	Public School	.63*	.121	.000	.33	.93
		Private School	1.13*	.121	.000	.83	1.42
	Public	Private School	.50*	.121	.000	.20	.79
AR-Perception	Language Institute	Public School	.49*	.113	.000	.21	.77
		Private School	1.03*	.113	.000	.76	1.31
	Public	Private School	.55*	.113	.000	.27	.83

**. The mean difference is significant at the .05 level.*

Gender-based comparisons, shown in Table 7, revealed no significant differences in mean scores across the four components of AR literacy.

Table 7.

Descriptive Statistics for Components of Augmented Reality by Gender

Dependent Variable	Gender	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Computer Skill	Male	2.435	.073	2.291	2.578
	Female	2.324	.065	2.197	2.451

AR-Experience	Male	2.395	.074	2.249	2.541
	Female	2.355	.066	2.226	2.484
AR-Practice	Male	2.359	.074	2.213	2.505
	Female	2.425	.066	2.295	2.555
AR-Perception	Male	2.392	.070	2.254	2.530
	Female	2.366	.062	2.244	2.488

This finding was corroborated by between-subjects effects in Table 8, indicating no variation between male and female teachers on Computer Skills, AR Experience, AR Practices, or AR Perceptions.

Table 8.

Descriptive Statistics for Components of Augmented Reality by Group by Gender

Dependent Variable	Group	Gender	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Computer Skill	Language Institute	Male	2.853	.129	2.599	3.107
		Female	2.825	.110	2.608	3.041
	Public	Male	2.614	.126	2.365	2.862
		Female	2.354	.112	2.134	2.574
	Private	Male	1.837	.123	1.594	2.080
		Female	1.793	.114	1.569	2.017
AR-Experience	Language Institute	Male	2.899	.131	2.641	3.157
		Female	2.815	.112	2.595	3.034
	Public	Male	2.449	.128	2.197	2.701
		Female	2.478	.114	2.254	2.701
	Private	Male	1.837	.125	1.590	2.084
		Female	1.773	.116	1.545	2.001
AR-Practice	Language Institute	Male	2.845	.132	2.586	3.104
		Female	3.082	.112	2.861	3.302
	Public	Male	2.443	.129	2.190	2.696
		Female	2.281	.114	2.057	2.506
	Private	Male	1.788	.126	1.540	2.036
		Female	1.912	.116	1.683	2.141
AR-Perception	Language Institute	Male	2.830	.124	2.587	3.074
		Female	2.927	.105	2.719	3.134
	Public	Male	2.446	.121	2.208	2.684
		Female	2.362	.107	2.151	2.573
	Private	Male	1.899	.118	1.667	2.132
		Female	1.810	.109	1.595	2.025

Similarly, no significant interaction effects between group and gender were observed for any component: Computer Skills ($F(2, 294) = .586$, $p > .01$, partial $\eta^2 = .004$), AR Experience ($F(2, 294) = .123$, $p > .01$, partial $\eta^2 = .001$), AR Practices ($F(2, 294) = 1.42$, $p > .01$, partial $\eta^2 = .010$), and AR Perceptions ($F(2, 294) = .426$, $p > .01$, partial $\eta^2 = .003$), all reflecting weak effect sizes.

4.2. Qualitative data analysis

To address the third research question, which explored the extent to which Iranian EFL teachers in public high schools, private high schools, and private language institutes utilized Augmented Reality (AR) in their classes, interview data were analyzed using thematic analysis. This involved initial (open) coding and axial coding to identify AR factors and their practical applications based on teachers' self-reported practices. In-depth interviews were conducted with 30 teachers, representing 10% of EFL teachers from each group, to gather insights into their AR literacy in practice.

Demographic information from the interviews, summarized in Table 9, revealed that 10 participants were instructors at private language institutes, 10 taught at public schools, and 10 were teachers at private (non-profit) schools. Of these, 13 were male, and 17 were female. Regarding educational background, 22 held a bachelor's degree, six had a master's degree, and two possessed a PhD. Teaching experience varied: one teacher had less than three years, two had four to six years, six had seven to

ten years, and 19 had over ten years. Nine teachers, primarily at private institutions, were not English majors, while 21 were English majors with backgrounds in English teaching, translation, or literature.

Table 9.

Descriptive Statistics; Demographic Information of the Interviewees

1	Gender	Male	13	Female	17
2	Age	23-30, N=6	31-40, N = 13	41-50, N= 8	Over 51, N=3
3	Edu. Background	B.A., N = 22	M.A., N = 6	Ph.D., N = 2	
4	Major	English, N =21		Other Majors, N=9	
5	Teaching Exp.	Less than 3 Years =11	4-6 years=4	7-10 years =6	More than 10=19
6	Teaching Place	Private Ins. N =10	State Schools., N=10		Private Sch., N= 10

Data analysis was conducted by two coders: the researcher and a colleague experienced in qualitative research. Thematic analysis was applied to the interview transcripts. The results are presented below by interview items.

Item One: *Do you know what Augmented Reality is?*

Teachers' awareness of AR and its components is summarized in Table 10. Most interviewees reported limited understanding, stating they "do not have a clear assumption of what AR is." Many equated AR with general computer skills, such as "using the internet, typing, showing videos, and searching," which represents only a partial aspect of AR (Zlatanova, 2002). For instance, one teacher remarked, "To me, AR is a user's ability and gained mastery over the ICDL [International Computer Driving License] package." Additionally, 46% of interviewees considered "using Twitter in the classroom" a form of AR. Another teacher noted, "I think using special devices such as goggles and internet systems as classroom support is what AR means."

Table 10.

EFL Teachers' Awareness of AR and Its Definition

Related Factors	Teachers			
	PIs	SSs	PSs	%
Using computer skills such as working with the net, typing, showing videos, and searching	6	8	10	80.00%
A teacher's usage of applications in the classroom.	4	5	4	43.33%
Using virtual reality in the classroom context.	5	3	4	40.00%
Using special devices such as Google and internet systems as classroom support by the teacher and as a part of students' homework.	3	5	6	46.66%

Note: Private Institutes (PIs), State Schools (SSs), and Private Schools (PSs)

Item Two: *Have you ever used AR in your classes? Explain, please.*

Most EFL teachers reported not using AR in their classes. However, some described activities they believed aligned with AR, such as asking students to watch online films in class, encouraging the use of social applications for English learning, and combining real and virtual information in lessons. One teacher commented, "*We do not have access to special goggles for AR classes, but we try to familiarize learners with the AR concept.*"

Item Three: *Which techniques do you use in your AR practices in the EFL classroom?*

Teachers reported using the AR techniques listed in Table 11. Results indicated that teachers at private language institutes employed these techniques more frequently than their counterparts at public or private high schools. Public high school teachers, however, reported greater use of these techniques than private high school teachers. The most cited technique was "watching online videos in the classroom" (83.33%), followed by "using Twitter as classroom support and part of students' homework" (66.66%), "encouraging students to use social applications to learn English" (63.33%), and "employing a combination of real and virtual information in the classroom" (60.00%).

Table 11.

The AR Techniques used by EFL Teachers in the Classroom

Techniques Used	Teachers			
	PIs	SSs	PSs	%
Watching online videos in the classroom	10	8	7	83.33%

Using Twitter as classroom support by the teacher and as a part of students' homework	8	6	6	66.66%
Encouraging students to use social applications to learn English	8	6	5	63.33%
Employing the combination of real and virtual information in the classroom	9	5	4	60.00%

Note: Private Institutes (PIs), State Schools (SSs), and Private Schools (PSs)

Item Four: *Which computer skills have you developed and used in your classes?*

Table 12 outlines the computer skills developed and used by the EFL teachers. Teachers at private language institutes demonstrated greater interest in developing and applying computer skills compared to those at public or private high schools. Public high school teachers were more engaged in using computer skills than private high school teachers.

Table 12.

Computer Skills Developed and Used by EFL Teachers in the Classroom

Computer Skills Used	Teachers			
	PIs	SSs	PSs	%
Working with test construction applications	8	7	6	70.00%
Using Vocabulary and grammar teaching applications in the classroom	8	6	6	66.66%
Technology, social media, and its related applications	9	6	4	63.33%
Ability and gained mastery over ICDL	8	6	4	60.00%
Knowledge of Virtual Reality	7	5	3	50.00%

Item Five: *Which apps installed on your mobile device are used in your class? How?*

Interviewees reported using applications such as Skyroom, Instagram, email, Skype, Adobe Connect, WhatsApp, Telegram, and Shad. Teachers at private language institutes used Instagram and WhatsApp to communicate with students, send lesson summaries, and receive homework. One teacher stated, "I usually ask my students to send their assignments via Telegram." Conversely, high school teachers reported being restricted to the Shad application, with other social media platforms prohibited. One interviewee noted, "If teachers use any social media besides Shad, they will be punished." Teachers at private (non-profit) schools reported using Skype and Skyroom, while some mentioned familiarity with BigBlueButton and Zoom, which they had also used in classes.

Item Six: *What otehr knowledge areas are better covered in an AR classroom?*

Teachers highlighted that AR applications on mobile devices and tablets could enhance learning by exposing students to cultural factors, artifacts, media, and geographical locations through interactive content, such as reading, watching films, and virtual exploration. One teacher explained, "*Through AR applications, students interact with content, move around it, get closer, and manipulate it to learn more effectively and meaningfully.*" Overall, AR was seen as facilitating communication by simulating native-like environments. Some teachers suggested that AR could support learning all language skills and components, potentially through virtual classes accessed via specialized goggles, allowing students to audit lessons delivered by teachers remotely.

5. Discussion

This mixed-methods study explored Iranian EFL teachers' augmented reality (AR) literacy across public high schools, private high schools, and private language institutes, focusing on their awareness, gender differences, and practical application of AR. Quantitative findings revealed that while teachers recognize AR components (i.e. computer skills, AR practices, AR experience, and AR perceptions) their knowledge remains limited. Private language institute teachers scored highest across all components, followed by public and private high school teachers, with public school teachers slightly outperforming their private school counterparts. These results align with Soleimani (2019), who emphasized AR's role as a scaffolding tool for collaborative learning, but corroborate Azuma (1997) and Belda-Medina and Calvo-Ferrer (2022) in highlighting teachers' limited practical AR expertise. A 2024 study by Wang and Lee (2024) further supports this point, noting that EFL teachers globally lack hands-on AR training, which hinders integration into language pedagogy. The low AR literacy among Iranian EFL teachers underscores the need for targeted professional development to bridge this gap.

No significant gender differences were observed in AR literacy, aligning with Hol and Aydin (2020) and Ardiç and Çiftçi (2019), who found gender neutrality in technology adoption among EFL teachers. This contrasts with Mahdi and Al-Dera (2013), who reported lower ICT use among female teachers in Nigerian L2 classrooms. The absence of gender disparity in Iran likely stems from limited access to AR-specific devices, such as headsets or tablets, and insufficient training, as noted in a 2025 report by UNESCO on digital divides in educational technology adoption (UNESCO, 2025). Systemic barriers, including the lack of AR infrastructure in Iran, exacerbate this issue, necessitating institutional investment in resources and training to foster equitable AR literacy across all EFL teachers.

Qualitative data confirmed that state and private high school teachers are largely unfamiliar with AR applications, often conflating them with basic digital tools, while private institute teachers exhibited greater awareness and enthusiasm for AR adoption, contingent on resource availability. This aligns with recent research by Cai (2022) and Garzón et al. (2022), which highlight AR's potential to enhance student motivation and engagement in EFL settings. A 2025 study by Chen (2025) further demonstrates that AR applications, such as mobile-based cultural simulations, significantly improve L2 learners' vocabulary acquisition and cultural competence. The limited AR use among Iranian EFL teachers reflects gaps in infrastructure and professional development. Future training programs must prioritize hands-on AR skills, enabling teachers to leverage its affordances for immersive L2 pedagogy.

6. Conclusion

This study revealed varying levels of AR literacy among Iranian EFL teachers, with private language institute teachers demonstrating the highest proficiency, followed by public and private high school teachers, who face constraints from educational regulations and limited resources. Institute teachers showed greater motivation to integrate AR, while high school teachers, particularly in private settings, lacked initiative without external support. These findings highlight the urgent need for professional development, specifically for teacher training in AR to enhance EFL classroom outcomes. Addressing these gaps is critical to enabling AR's effective integration into Iranian EFL contexts.

Gender had no significant impact on AR literacy, reflecting systemic barriers such as the scarcity of AR devices and services in Iran. Teachers' understanding of AR was often limited to basic digital skills, underscoring the need for comprehensive training to unlock AR's potential for creating engaging, culturally rich learning experiences. Such training could facilitate cognitive comparisons and learner autonomy as well as improved L2 fluency and motivation.

Future research should investigate AR's long-term effects on learners' linguistic development, such as vocabulary and grammar retention, through longitudinal studies. Exploring learners' AR awareness across proficiency levels and conducting experimental studies in real classroom settings could further validate AR's efficacy. By addressing these research gaps and enhancing teacher training, educators and materials developers can harness AR to transform EFL teaching, fostering interactive and effective L2 learning environments in Iran and globally.

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8. Appendices

8.1. Appendix A

FFL Teachers' Augmented Reality (AR) Literacy

Amiri & Nezakatgoo (2019)

Dear Respondent

The present questionnaire aims at measuring your understanding of computer skills and Augmented Reality. For your information, AR is defined as the ability to overlay computer graphics onto the real world. In AR interfaces, unlike immersive Virtual Reality, users see the real world at the same time as virtual imagery attached to real locations and objects. Your cooperation is appreciated in advance.

A: Demographic Questions

1. What is your gender? A. Male B. Female
2. What is your age? A. 23 - 30 B. 31 - 40 C. 41 - 50 D. 51 and above
3. Educational Background: A. B.A. B. M.A. C. PhD
4. What is your major? A. English B. Other Majors
5. How many years of teaching experience do you have?
   A. Less than 3 years B. 4-6 years C. 7-10 years D. More than 10
6. Where do you teach English?
   A. Private Language Institutes B. State Schools C. Private (Non-profit) Schools

B: Augmented Reality Factors

None= (1), Low= (2), Average= (3), High= (4), Very high= (5)

No.	Description	1	2	3	4	5
1	How do you rate your computer skill?					
2	How much of interest do you have in technology?					
3	How well do you know what Augmented Reality (واقعیت افزوده) is?					
4	To what extent have you experienced on line lectures in your place?					
5	To what extent have you experienced translating with your webcam?					
6	To what extent have you experienced interactive on-line discussions?					
7	To what extent have you gained mastery over ICDL* package? *معنی: ICDL گواهینامه ای بین المللی کاربری رایانه است که توسط بنیاد ای سی دی ال ارائه شده و دریافت آن به معنی رسیدن به درجه ای از مهارت در کار با رایانه است که فرد توانایی های اصلی و مهارت های مقدماتی کار با رایانه را دارد.					

8	To what extent have you experienced virtual classes?					
9	To what extent you think the apps with AR function replicate real situations?					
10	How you rate your own usage of applications in your classroom?					
11	To what extent do you watch on line films in your classroom?					
12	To what extent do you use Twitter in your students' homework?					
13	To what extent do you encourage your students to use social applications to learn English?					
14	How do you evaluate your own IT (فنـاوری اطلاعـات) ability?					
15	To what extent do you use the combination of real and virtual information in the classroom?					
	In Questions 16-22, please rate how strongly you agree or disagree with the following statement. **Completely Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5)**	1	2	3	4	5
16	The App with AR function has more features and contents.					
17	The App with AR function supports different operating systems.					
18	The App with AR function locates and recognize the scene precisely (i.e. objects in the real and virtual worlds are properly matched).					
19	The App with AR function enriches the real world by combining real and virtual information.					
20	The App with AR function improves the online learning experience.					
21	The App with AR function helps students feel the target language environment in the virtual form.					
22	AR is the real world but it is extended with some digital content.					

Key to the Variables:

Computer Skills: 1, 2, 3, 7, 10, 14 **AR Practices:** 11, 12, 13, 15

AR Experience: 4, 5, 6, 8 **AR Perceptions:** 9, 16, 17, 18, 19, 20, 21, 22

8.2. Appendix B

Interview Protocol along with In-text Citations

Purpose: The present interview aims to elicit the attitudes of Iranian EFL teachers about AR and their AR literacy (AlSuwaihel, 2024; Amiri & Nezakatgoo, 2019; Chen et al., 2025)

Ethics: Confidentiality assurance is taken into account in this interview. Hence, the participants' responses will be kept confidential and used only for research purposes (Creswell & Plano Clark, 2023). Moreover, the participants may choose to withdraw from the interview at any time (Creswell, 2021).

Duration: This interview will take approximately 10-15 minutes. In the follow up session(s), the participants will be provided with the final summary of the findings so that they could scrutinize the findings and see if the information actually come from their perceptions (Creswell & Plano Clark, 2023; Mackey & Gass, 2015).

A: Demographics:

7. What is your gender? A. Male B. Female

8. What is your age? A. 23 - 30 B. 31 - 40 C. 41 - 50 D. 51 and above

9. Educational Background: A. B.A. B. M.A. C. PhD

10. What is your major? A. English B. Other Majors

11. How many years of teaching experience do you have?

A. Less than 3 years B. 4-6 years C. 7-10 years D. More than 10

12. Where do you teach English?

A. Private Language Institutes B. State Schools C. Private (non-profit) Schools

B: Main Questions

Purpose	Questions & Citations
Eliciting EFL Teachers' Awareness of AR	**1.** Do you know what Augmented Reality (واقعیت افزوده) is? (AlSuwaihel, 2024; Amiri & Nezakatgoo, 2019; Chen et al., 2025; Wu et al., 2018)
Eliciting teachers' attitudes about the application of AR in their classroom	**2.** Have you ever used AR in your classes? Explain, please. (Azuma, 1997; Zhang et al., 2020) **3.** Which techniques do you use in your AR practices in the EFL classroom? (Parmaxi & Demetriou, 2020; Yang & Mei, 2018)
Eliciting EFL teachers' attitudes about their computer skills	**4.**Which computer skills have you developed and used in your classes? (AlSuwaihel, 2024; Tosto et al., 2021) **5.**Which of the apps you have installed on your mobile are used in your class? How? (Amiri et al., 2025; Nikimaleki & Rahimi, 2022; Syahriani & Hasruddin, 2024)
Eliciting EFL teachers' final thoughts	**6.**What other knowledge areas are better covered in an AR classroom? (Annamalai et al., 2023; Simonova & Kolesnichenko, 2022)