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A technology acceptance model-based study of teachers' readiness for augmented reality in Uzbekistan

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ABSTRACT

Teacher readiness determines whether investments in educational technology translate into classroom practice, yet readiness for augmented reality (AR) remains understudied, particularly in Central Asia. This study examined teachers' readiness and perceptions toward AR adoption using the technology acceptance model (TAM), drawing on data from Uzbekistan, a setting largely absent from the AR adoption literature. A quantitative cross-sectional survey was administered to 56 purposively sampled teachers from secondary schools and higher education institutions, and the data were analyzed through reliability analysis, descriptive statistics, Pearson correlations, and multiple linear regression in SPSS. Teachers reported high readiness (M=4.53, SD=0.63) and positive perceptions in both contexts. Overall perception was the only fully significant predictor of readiness (β=0.46, p=0.007), perceived usefulness (PU) was marginal (β=0.41, p=0.056), and the model explained 48.8% of variance in readiness. To our knowledge, this is the first empirical TAM-based study of teacher readiness for AR in Uzbekistan and the wider Central Asian region. The findings indicate that institutional investment in infrastructure and structured professional development is needed to convert high motivational readiness into sustained classroom practice.

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1. INTRODUCTION

Augmented reality (AR) has become one of the more widely discussed educational technologies of the past decade. By overlaying digital content onto the physical world, AR enables learners to interact with abstract concepts in ways that conventional instruction cannot replicate. Classroom applications of AR support visualization, promote active learning, and have been shown to improve student engagement and retention across subject areas [1], [2]. Research output on AR in education has grown substantially since 2018, reflecting broad international interest in its instructional potential [3], [4]. Despite this growth, most studies concentrate on student outcomes, while the conditions needed for teachers to successfully adopt AR have received comparatively less attention.

Teachers are the primary decision-makers in technology integration. Their readiness, which encompasses perceived value, technical confidence, and behavioral intention, is a necessary precondition for any technology to move from availability to actual classroom use [5], [6]. Studies consistently find that educators view AR positively in principle but feel underprepared to implement it, citing insufficient training, unclear pedagogical guidance, and limited institutional support [7]–[10]. Understanding what drives readiness, and how those drivers operate across different institutional contexts, is a prerequisite for effective AR adoption strategy.

The technology acceptance model (TAM) [11] offers a theoretically grounded and widely validated framework for this purpose. TAM identifies two core antecedents of adoption intention: perceived usefulness (PU), which refers to the degree to which a technology is believed to improve performance, and perceived ease of use (PEOU), which refers to how little effort a user believes the technology requires. Despite TAM's established utility in educational technology research, its application to AR adoption readiness among in-service teachers remains limited [12], [13].

If teacher readiness for AR is not well understood, the educational consequences are concrete and costly. AR tools procured through national digital education budgets remain unused when teachers lack the readiness to deploy them, which wastes scarce public investment and widens the gap between technology availability and instructional practice. Students are then denied the documented learning benefits of AR, and reform initiatives stall at the level of infrastructure without reaching the classroom [14], [15]. Misdiagnosing the source of low readiness, for example by funding hardware when the real barrier is attitudinal or pedagogical, can entrench rather than resolve the problem. Understanding the determinants of readiness is therefore a precondition for any effective AR adoption strategy in a developing educational system.

Geographically, the existing literature is concentrated in Western and East Asian contexts [15]. Central Asia, including Uzbekistan, where educational digitalization is accelerating, is almost entirely absent from the AR adoption literature. This gap matters because evidence from transitional economy contexts can test the generalizability of TAM-based findings and produce actionable recommendations for a region where AR infrastructure and professional development are still developing [16], [17]. To make this geographical gap explicit: while AR acceptance has been studied extensively in Western Europe and East Asia, no prior empirical study has examined teacher AR readiness anywhere in Central Asia, leaving a five-country region with more than 70 million people entirely outside the international evidence base. This study is the first to address that gap.

In Uzbekistan, national reform has accelerated investment in digital infrastructure, but teacher preparation for technologies like AR has not kept pace. Almost no published evidence exists on how Uzbekistani teachers perceive or approach AR adoption [16]. The primary obstacle to AR integration is not the technology itself but the readiness of the teachers expected to use it; without sufficient readiness, AR tools remain unused regardless of availability [5], [6]. This challenge is particularly visible in mixed-context studies that include both school and higher education teachers, since the two groups face structurally different constraints. School teachers operate under tighter curriculum controls and more limited discretionary technology access, while higher education faculty may have greater autonomy but fewer systematic professional development structures [7], [18].

Most existing research has examined AR from the student perspective, measuring learning outcomes after AR-based instruction [1], [2], [19]. The pre-implementation stage, what teachers know, believe, and feel about AR before committing to its use, has received substantially less attention [6], [18]. Comparable evidence from adjacent settings, including business and marketing education [20] and higher education science instruction [21], shows that the same usefulness and ease-of-use mechanisms shape adoption across disciplines, while studies of prospective teachers' attitudes toward AR confirm that attitudinal orientation is central to readiness [22]. Without evidence on the factors that shape readiness, institutions in transitional economies like Uzbekistan lack the empirical basis needed to design effective teacher preparation and AR support programs.

This study aims to address that gap. It examines teachers' readiness and perceptions toward AR integration in Uzbekistan, and identifies the TAM-based factors that predict adoption readiness at the pre-implementation stage. The study specifically tests the predictive effects of PU, PEOU, and overall perception on teachers' readiness, and explores whether these effects hold across school and higher education contexts [11]. Four research questions guided this study:

- What are teachers' perceptions of AR integration in Uzbekistan?
- To what extent are teachers ready to adopt AR technologies?
- How do PU and PEOU influence teachers' readiness?
- What is the relationship between teachers' overall perceptions and their readiness to implement AR?

Furthermore, six hypotheses were tested based on TAM theory [11]: i) PU has a positive effect on readiness (H1); ii) PEOU has a positive effect on readiness (H2); iii) PU has a positive effect on perception (H3); iv) PEOU has a positive effect on perception (H4); v) perception has a positive effect on readiness (H5); and vi) PEOU has a positive effect on PU (H6). The conceptual model is presented in Figure 1.

This study matters because teacher readiness, rather than technology availability, determines whether AR implementation succeeds and whether educational technology investments produce returns. In transitional economies that are committing public funds to digital education, identifying the determinants of readiness is essential for directing those funds effectively. The study offers three contributions. Theoretically, it extends TAM to AR adoption in a Central Asian context currently absent from the literature,

and shows that holistic perception outweighs individual TAM dimensions as a readiness predictor at the pre-adoption stage. Practically, it provides evidence to guide institutional investment priorities, professional development design, and AR implementation strategy in Uzbekistan and comparable developing systems. As a contribution to the literature, it provides the first replicable, TAM-grounded baseline dataset for future longitudinal and comparative research across Central Asia [17], [23].

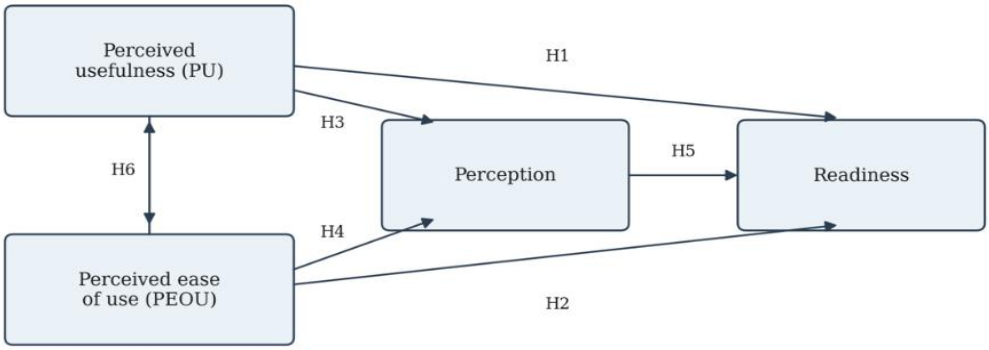


Figure 1. Conceptual framework based on TAM for AR integration in education

2. METHOD

2.1. Research design

A quantitative cross-sectional survey design was used. Cross-sectional designs are appropriate when the research objective is to identify relationships and patterns across variables at a specific point in time [24], consistent with this study's aim of characterizing the current state of teacher AR readiness in Uzbekistan. The study was theoretically grounded in TAM [11], which identifies PU and PEOU as the key determinants of technology adoption intention and has been validated across diverse educational technology contexts [12].

2.2. Participants and sampling

Participants were recruited from secondary schools and higher education institutions in Uzbekistan using purposive sampling. Purposive sampling was chosen deliberately rather than for convenience: the research questions concern teachers who have at least some awareness of digital tools and can respond meaningfully to AR-specific survey items, and a purposive strategy is the standard approach for reaching such an informed subgroup in an early-adoption context where AR-experienced teachers are not evenly distributed across the population. As a transitional economy with a rapidly expanding higher education sector and ongoing national digital education reform, Uzbekistan represents a setting where AR technologies are at an early adoption stage, making teacher readiness research both timely and policy-relevant. The final sample comprised N=56 teachers: 29 from secondary schools (51.8%), 19 from higher education institutions (33.9%), and 8 from other institutional settings (14.3%). This sample size is adequate for the correlation and multiple regression analyses applied here: with three predictors, it satisfies the common minimum of $N \geq 50+8$ per predictor for multiple regression, and it exceeds the threshold required to detect medium-to-large effects at conventional power levels [24]. The sample is nonetheless best understood as a pilot baseline for a previously unstudied context, and replication with larger, probability-based samples is recommended before generalizing beyond this setting.

2.3. Instrument

A structured Likert-scale questionnaire was developed based on established TAM constructs [11]. The instrument included two sections: i) demographic items (gender, age, teaching experience, subject area, institutional level); and ii) TAM constructs: PU (4 items), PEOU (4 items), readiness (4 items), overall perception (4 items), and barriers (4 items), each rated on a five-point scale (1=strongly disagree to 5=strongly agree). Items were adapted from validated instruments in prior educational technology acceptance research [12].

The instrument underwent a two-stage validation process before deployment. First, content validity was established through expert review: three specialists in educational technology and pedagogy independently evaluated each item against the construct it was intended to measure, judging relevance, clarity, and wording. Items flagged as ambiguous were revised or removed before piloting, and only items with full expert agreement on construct relevance were retained. Second, the revised instrument was

pilot-tested with a small group of teachers drawn from the target population but excluded from the main sample, to check item comprehension and completion time. Construct reliability was then confirmed in the main study through Cronbach's alpha. The questionnaire was administered via Google Forms in bilingual format (Uzbek and English) to reduce language-related measurement error. Because the TAM items were adapted to the Uzbekistani educational context and administered bilingually, content validity was treated as the central concern: the expert panel specifically checked that each translated item preserved the meaning of its original construct, and the high internal consistency subsequently obtained (α=0.815–0.921) provided convergent evidence that the adapted scales measured coherent constructs. Full construct-validity testing through confirmatory factor analysis was not feasible at this sample size and is recommended for future work.

2.4. Data analysis

Data were analyzed in SPSS through four stages: i) reliability analysis (Cronbach's alpha) to verify internal consistency; ii) descriptive statistics (means, standard deviations) to characterize readiness and perceptions; iii) Pearson correlation analysis to examine bivariate relationships among PU, PEOU, perception, and readiness; and iv) multiple linear regression with readiness as the dependent variable. Multicollinearity was assessed using variance inflation factors (VIF) and tolerance statistics, with accepted thresholds of VIF<5 and tolerance >0.10 [25].

2.5. Ethical considerations

The study followed ethical principles for human subject research. Participants were informed of the study's purpose before responding, no personal identifying information was collected, participation was entirely voluntary, and all data were stored securely for academic use only.

3. RESULTS AND DISCUSSION

3.1. Participant demographics

Table 1 presents the demographic profile of the 56 Uzbekistani participants. The sample was 83.9% female and 16.1% male, with a mean age of 37.4 years (SD=8.1) and mean teaching experience of 12.0 years (SD=9.1). Secondary school teachers formed the largest subgroup (51.8%), followed by higher education faculty (33.9%). Subject specializations spanned informatics, Uzbek language and literature, English, mathematics, economics, and other fields.

Table 1. Demographic profile of participants (N=56)

Variable	Category	*n*	%
Gender	Female	47	83.9
	Male	9	16.1
Age	20–25	3	5.4
	26–35	22	39.3
	36–45	25	44.6
	46+	6	10.7
Teaching experience	1–5 years	11	19.6
	6–10 years	12	21.4
	11–20 years	15	26.8
	20+ years	10	17.9
	Not specified	8	14.3
Teaching level	Secondary school	29	51.8
	Higher education	19	33.9
	Other	8	14.3

3.2. Reliability of constructs

All five constructs in the instrument exceeded the recommended internal consistency threshold of α>0.70 [25], as shown in Table 2. Cronbach's alpha values ranged from 0.815 for barriers to 0.921 for PU. These values indicate that the measurement instrument had adequate to excellent internal consistency. The reliability results confirmed that the construct scores were suitable for the correlation and regression analyses.

3.3. Descriptive statistics

Table 3 reports descriptive statistics for the five constructs. Uzbekistani teachers reported very high readiness (M=4.53, SD=0.63) and positive perceptions (M=4.44, SD=0.75) toward AR integration. PU (M=4.49) was rated slightly higher than PEOU (M=4.27). Barriers were rated at a moderately high level (M=3.98). All four readiness and perception constructs fell in the high to very high range, while the barriers construct sat lower, in the moderate range.

Table 2. Reliability analysis of constructs

Construct	Items	Cronbach's α	Interpretation
PU	4	0.921	Excellent
PEOU	4	0.857	Very good
Readiness	4	0.850	Very good
Perception	4	0.866	Very good
Barriers	4	0.815	Good

Table 3. Descriptive statistics (N=56)

Variable	M	SD	Range	Interpretation
PU	4.49	0.72	2.00–5.00	High
PEOU	4.27	0.80	1.50–5.00	High
Readiness	4.53	0.63	2.50–5.00	Very high
Perception	4.44	0.75	2.00–5.00	High
Barriers	3.98	0.84	1.75–5.00	Moderate

3.4. Institutional barriers

Table 4 ranks the four barrier items by mean score. Technical difficulties (M=4.07) and limited device access (M=4.05) received the highest ratings, followed by lack of training (M=4.02). The time barrier was rated lowest (M=3.77). The three highest-ranked barriers were all structural rather than time-related, indicating that infrastructure and training, not scheduling, are the most prominent perceived obstacles in this sample.

Table 4. Descriptive statistics for barriers subscale

Barrier	M	SD	Rank
Technical difficulties hinder integration	4.07	1.06	1
Limited access to devices	4.05	0.92	2
Lack of training prevents adoption	4.02	1.02	3
Lack of time	3.77	1.19	4

3.5. Correlation analysis

Table 5 presents the Pearson correlation matrix. All correlations were positive and statistically significant ($p<0.001$). Perception showed the strongest association with readiness ($r=0.671$), followed by PU ($r=0.631$) and PEOU ($r=0.436$). PU and PEOU were strongly intercorrelated ($r=0.796$). This high intercorrelation between the two core TAM antecedents is noted here and is examined in the regression analysis that follows.

Table 5. Pearson correlation matrix (N=56)

Variable	1	2	3	4
1. PU	1			
2. PEOU	0.796**	1		
3. Perception	0.793**	0.630**	1	
4. Readiness	0.631**	0.436**	0.671**	1

Note: **Correlation is significant at the 0.01 level (2-tailed).

3.6. Multiple regression analysis

Table 6 reports the multiple regression results with readiness as the dependent variable. The model was statistically significant, $F(3, 52)=16.51$, $p<0.001$, accounting for 48.8% of the variance in readiness ($R^2=0.488$, adjusted $R^2=0.458$). Perception was the only fully significant predictor ($\beta=0.460$, $p=0.007$). PU showed a marginal effect ($\beta=0.408$, $p=0.056$), and the regression coefficient for PEOU was negative and non-significant ($\beta=-0.178$, $p=0.281$). All VIF values fell below 5 (PU=4.44, PEOU=2.73, perception=2.70).

Table 6. Multiple regression analysis: predictors of readiness

Predictor	B	SE	β	t	p	VIF
(Constant)	1.804	0.411	—	4.395	<0.001	—
PU	0.358	0.183	0.408	1.954	0.056	4.44
PEOU	-0.141	0.130	-0.178	-1.089	0.281	2.73
Perception	0.387	0.137	0.460	2.822	0.007	2.70

3.7. Hypothesis testing

Table 7 summarizes the hypothesis testing outcomes. Four of the six hypotheses were fully supported (H3, H4, H5, H6); H1 was marginally supported; and H2 was not supported as an independent regression effect, although its positive bivariate correlation with readiness ($r=0.436$) was statistically significant.

Table 7. Hypothesis testing summary

H	Path	Outcome	Evidence
H1	PU → Readiness	Marginal	β=0.41, p=0.056
H2	PEOU → Readiness	Not supported*	β=-0.18, p=0.281
H3	PU → Perception	Supported	r=0.79, p<0.001
H4	PEOU → Perception	Supported	r=0.63, p<0.001
H5	Perception → Readiness	Supported	β=0.46, p=0.007
H6	PEOU → PU	Supported	r=0.80, p<0.001

*H2 non-significance in regression reflects multicollinearity with PU (VIF=4.44), not the absence of a bivariate relationship.

3.8. Discussion

The regression model accounted for 49% of the variance in teacher readiness, indicating that perception, PU, and PEOU together capture most of the relevant attitudinal variance. A central theoretical contribution of this study is to show how the TAM operates in a developing-country, early-adoption context that differs from the Western and East Asian settings where the model is usually tested. The discussion is organized around four themes.

First, perception emerged as the only fully significant predictor of readiness (β=0.460), while the two classic TAM antecedents behaved differently than in mature-adoption settings. In contexts where teachers have limited direct AR experience, a holistic attitude toward AR, integrating beliefs about its educational value, its fit with existing pedagogy, and its future relevance, appears to be the most proximal predictor of readiness. This extends TAM by suggesting that in developing-country, pre-adoption conditions, the aggregated perception construct carries more diagnostic weight than the individual usefulness and ease-of-use components. Huang and Musah [26] found that teachers who recognized AR's capacity to support creativity and active learning were the most motivated to integrate it, and Fernandez-Herrero *et al*. [12] observed that participatory exposure to AR with clear pedagogical benefits shifted adoption intention more than ease-of-use gains alone. Evidence that AR combined with game-based learning raises intrinsic motivation [27], and that teachers who act as AR designers develop stronger pedagogical ownership [28], reinforces this interpretation. The practical implication for teacher training is that professional development in Uzbekistan should center on demonstrating AR's educational relevance through direct experience rather than on technical skill-building. This is a theoretical extension rather than a confirmation of TAM: the standard model treats PU and PEOU as the dominant antecedents, but in a resource-constrained, early-adoption system these specific cognitive beliefs are not yet grounded in direct experience, so teachers fall back on a holistic, affect-laden appraisal of AR. In such settings the aggregated perception construct behaves as a higher-order attitude that absorbs and outweighs the individual cognitive beliefs, which suggests TAM should be specified differently for emerging educational contexts than for mature-adoption ones.

Second, the high mean readiness score (M=4.53) among Uzbekistani teachers is encouraging but warrants careful interpretation. In early-adoption settings, high stated readiness often reflects aspiration rather than experiential competence. Sukmawati *et al*. [16] reported similarly high readiness in comparable science, technology, engineering, and mathematics (STEM) contexts, noting the coexistence of strong motivational orientation with significant structural constraints, and the barriers data in this study (M=3.98) confirm that pattern. Perifanou *et al*. [5] documented the same tension across multiple national contexts, finding that attitudinal readiness and practical implementation gaps can persist simultaneously. For developing-country policy, this means motivational readiness should not be read as implementation capacity: the gap between the two is where infrastructure and training investment is required. Not all findings converge, however, whereas Alsadoon and Alhussain [7] reported that PEOU was a strong independent driver of AR acceptance among well-resourced higher education faculty, ease of use did not emerge as an independent predictor in the present sample. This contrast suggests that the relative weight of TAM constructs is context-dependent, and that ease-of-use effects documented in well-resourced settings may not transfer directly to early-adoption systems where infrastructure itself is uncertain.

Third, the study included secondary school teachers (51.8%) and higher education faculty (33.9%), enabling a cross-institutional perspective. These two populations operate under structurally different conditions: higher education faculty typically have greater curriculum flexibility and technology autonomy, while school teachers face tighter timetable constraints and more limited discretionary device access [7], [18]. Alsadoon and Alhussain [7] found that higher education faculty confidence in AR reflected this greater autonomy. The uniformly high mean scores in this study suggest that motivational readiness is cross-contextual in Uzbekistan, but the absence of a formal sub-group statistical comparison is a limitation; future studies should explicitly test whether readiness predictors differ between Uzbekistani school and higher education populations, since these sectors receive structurally different levels of digital education investment.

Fourth, the barriers subscale revealed that technical difficulties (M=4.07), limited device access (M=4.05), and insufficient training (M=4.02) are the most pressing structural obstacles for Uzbekistani

teachers. Nijhawan *et al*. [29] identified the same set as the foremost institutional constraints on AR adoption globally, and their prominence in this Uzbekistani sample aligns with the infrastructural realities of a transitional economy undergoing digital reform. Lin *et al*. [30] showed that institutionally embedded teacher learning communities produce significantly better AR integration outcomes than isolated professional development workshops, and Wyss and Bäuerlein [31] found that motivated teachers reduced AR use when institutional scheduling and infrastructure support was withdrawn. The practical implication for infrastructure development and education policy is direct: high individual readiness is necessary but not sufficient, and sustained institutional commitment to device procurement, AR content development, and structured teacher support is equally required.

3.9. Limitations

Several limitations should be noted. First, the sample (n=56) was drawn purposively from Uzbekistan and should not be generalized to the broader Uzbekistani teaching population without replication using probability-based sampling. Second, the cross-sectional design captures attitudes at a single point in time and therefore cannot establish causal or temporal relationships among the TAM constructs; the directional paths implied by the model remain associational, and longitudinal or experimental designs would be required to test causality. Third, self-report bias may inflate positive scores; triangulation with classroom observation or interview data is recommended. Fourth, multicollinearity between PU and PEOU (r=0.796, VIF=4.44) limited interpretation of individual regression coefficients, and future research should apply structural equation modeling to decompose the TAM causal structure. Fifth, the female-dominant sample (83.9%) may not represent gender-balanced educational populations. Finally, the single national context limits direct comparison with other Central Asian educational systems. In addition, because all variables were measured with a single self-administered questionnaire, common method bias cannot be ruled out; future studies should separate measurement of predictors and outcomes or apply statistical remedies such as Harman's single-factor test or a marker-variable approach.

4. CONCLUSION

This study investigated teacher AR adoption readiness in Uzbekistan using the TAM, drawing on survey data from 56 school and higher education teachers. Teachers reported very high readiness (M=4.53) and positive perceptions across both institutional contexts, with strong instrument reliability (α=0.815–0.921). The regression model (R^2=0.488) confirmed that overall perception is the strongest and only fully significant predictor of readiness (β=0.460, p=0.007), while high intercorrelation between PU and PEOU explained the instability of their individual contributions. The central contribution is to show that, in a developing-country early-adoption context, holistic attitudinal orientation outweighs the individual TAM dimensions as a readiness predictor, and that high motivational readiness coexists with significant structural barriers.

These findings carry clear practical implications: institutions should prioritize professional development that demonstrates AR's pedagogical relevance through hands-on experience, invest in device availability and technical support, and build teacher learning communities, while national policy should integrate AR teacher readiness into digital education frameworks with targeted funding for devices, content, and certified training. The study is limited by its small purposive sample, cross-sectional design, and single national context. Future research should therefore use larger probability-based samples with explicit school versus higher education comparison, apply structural equation modeling to model the full TAM causal structure, and adopt longitudinal and mixed-method designs to examine whether high readiness translates into sustained AR adoption.

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AUTHOR CONTRIBUTIONS STATEMENT

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study. Participants were informed of the purpose of the research before responding, participation was entirely voluntary, and no personal identifying information was collected.

ETHICAL APPROVAL

The research related to human use has been complied with all the relevant national regulations and institutional policies in accordance with the tenets of the Helsinki Declaration.

DATA AVAILABILITY

The data that support the findings of this study are available on request from the corresponding author, [DS]. The data are not publicly available due to privacy and ethical restrictions concerning research participants.

REFERENCES

[1] M. B. Ibáñez, Á. Di Serio, D. Villarán, and C. D. Kloos, "Experimenting with electromagnetism using augmented reality: impact on flow student experience and educational effectiveness," *Computers & Education*, vol. 71, pp. 1–13, Feb. 2014, doi: 10.1016/j.compedu.2013.09.004.

[2] J. Cabero-Almenara, J. Barroso-Osuna, C. Llorente-Cejudo, and M. del M. F. Martínez, "Educational uses of augmented reality (AR): experiences in educational science," *Sustainability*, vol. 11, no. 18, p. 4990, Sep. 2019, doi: 10.3390/su11184990.

[3] A. D. Samala *et al.*, "Global publication trends in augmented reality and virtual reality for learning: the last twenty-one years," *International Journal of Engineering Pedagogy*, vol. 13, no. 2, pp. 109–128, Mar. 2023, doi: 10.3991/ijep.v13i2.35965.

[4] S. Oueida, P. Awad, and C. Mattar, "Augmented reality awareness and latest applications in education: a review," *International Journal of Emerging Technologies in Learning*, vol. 18, no. 13, pp. 21–44, Jul. 2023, doi: 10.3991/ijet.v18i13.39021.

[5] M. Perifanou, A. A. Economides, and S. A. Nikou, "Teachers' views on integrating augmented reality in education: needs, opportunities, challenges and recommendations," *Future Internet*, vol. 15, no. 1, p. 20, Dec. 2023, doi: 10.3390/fi15010020.

[6] J. Piedade and E. Batista, "Teachers' perceptions of augmented reality in education: between pedagogical potential and technological readiness," *Education Sciences*, vol. 15, no. 8, p. 1076, Aug. 2025, doi: 10.3390/educsci15081076.

[7] H. Alsadoon and T. Alhussain, "Faculty at Saudi Electronic University attitudes toward using augmented reality in education," *Education and Information Technologies*, vol. 24, no. 3, pp. 1961–1972, May 2019, doi: 10.1007/s10639-018-9826-z.

[8] A. Ashely-Welbeck and D. Vlachopoulos, "Teachers' perceptions on using augmented reality for language learning in primary years programme (PYP) education," *International Journal of Emerging Technologies in Learning*, vol. 15, no. 12, pp. 116–135, Jun. 2020, doi: 10.3991/ijet.v15i12.13499.

[9] R. A. Hamid, I. M. Ismail, and W. A. J. W. Yahaya, "Augmented reality for skill training from TVET instructors' perspective," *Interactive Learning Environments*, vol. 32, no. 4, pp. 1291–1299, Apr. 2024, doi: 10.1080/10494820.2022.2118788.

[10] K. Nimon, L. R. Zientek, and R. K. Henson, "The assumption of a reliable instrument and other pitfalls to avoid when considering the reliability of data," *Frontiers in Psychology*, vol. 3, p. 102, 2012, doi: 10.3389/fpsyg.2012.00102.

[11] F. D. Davis, "Perceived usefulness, perceived ease of use, and user acceptance of information technology," *MIS Quarterly: Management Information Systems*, vol. 13, no. 3, pp. 319–340, Sep. 1989, doi: 10.2307/249008.

[12] J. Fernandez-Herrero, M. Urrea-Solano, and J. F. Alvarez-Herrero, "Participatory evaluation of an educational augmented reality application in development using the technology acceptance model (TAM)," *Discover Education*, vol. 5, no. 1, p. 345, Mar. 2026, doi: 10.1007/s44217-026-01377-1.

[13] A. Sangodiah, W. C. Yi, A. N. B. Ayob, N. B. A. Jalil, C. R. S. P. R. Subramaniam, and G. Lirong, "Machine learning clustering analysis towards educator's readiness to adopt augmented reality as a teaching tool," *Mendel*, vol. 29, no. 2, pp. 147–154, Dec. 2023, doi: 10.13164/mendel.2023.2.147.

[14] G. Pérez-López-de-Echazarreta, M. C. Sáiz-Manzanares, M. C. Escolar-Llamazares, and L. Alves-Gomes, "Augmented reality vs. 2D in basic dental education: learning outcomes, visual fatigue, and technology acceptance—a mixed methods study," *Applied Sciences*, vol. 16, no. 3, p. 1269, Jan. 2026, doi: 10.3390/app16031269.
[15] I. Yulianawati, Z. W. Lestari, N. Anggrarini, and Syafryadin, "Needs analysis for developing augmented reality-based critical reading materials for EFL students," *Studies in English Language and Education*, vol. 12, no. 3, pp. 1346–1361, Sep. 2025, doi: 10.24815/siele.v12i3.43391.
[16] W. Sukmawati *et al.*, "Teachers' readiness and perceptions of augmented reality for sustainable STEM education," *AMPLITUDO: Journal of Science and Technology Innovation*, vol. 5, no. 1, pp. 53–66, Feb. 2026, doi: 10.56566/amplitudo.v5i1.505.
[17] A. Şakir, "Augmented reality in preschool settings: a cross-sectional study on adoption dynamics among educators," *Interactive Learning Environments*, vol. 33, no. 4, pp. 2954–2977, Apr. 2025, doi: 10.1080/10494820.2024.2428361.
[18] V. Marín-Díaz and B. E. Sampedro-Requena, "Views of secondary education teachers on the use of mixed reality," *Frontiers in Education*, vol. 7, Jan. 2023, doi: 10.3389/feduc.2022.1035003.
[19] J. H. Lo, Y. F. Lai, and T. L. Hsu, "The study of AR-based learning for natural science inquiry activities in Taiwan's elementary school from the perspective of sustainable development," *Sustainability*, vol. 13, no. 11, p. 6283, 2021, doi: 10.3390/su13116283.
[20] Q. Lin and C. S. Ironsi, "Incorporating augmented reality into teaching marketing strategies: Perspectives from business education teachers and students," *International Journal of Management Education*, vol. 22, no. 3, 2024, doi: 10.1016/j.ijme.2024.101080.
[21] L. Ayaichi, A. Amaaz, and A. Mouradi, "Acceptance of augmented reality via mobile devices by higher education students in physics practical work," *Journal of Baltic Science Education*, vol. 24, no. 4, pp. 611–623, 2025, doi: 10.33225/jbse/25.24.611.
[22] A. Umirbekova, "Evaluation of the relationship between prospective teachers' perceptions of universal design for learning, inclusive learning attitudes, and augmented reality applications attitude," *International Journal of Education and Practice*, vol. 14, no. 2, pp. 288–301, Apr. 2026, doi: 10.18488/61.v14i2.4895.
[23] Y. O'Connor and C. Mahony, "Exploring the impact of augmented reality on student academic self-efficacy in higher education," *Computers in Human Behavior*, vol. 149, p. 107963, Dec. 2023, doi: 10.1016/j.chb.2023.107963.
[24] X. F. Lin *et al.*, "Promoting pre-service teachers' learning performance and perceptions of inclusive education: an augmented reality-based training through learning by design approach," *Teaching and Teacher Education*, vol. 148, p. 104661, Oct. 2024, doi: 10.1016/j.tate.2024.104661.
[25] C. Maier, J. B. Thatcher, V. Grover, and Y. K. Dwivedi, "Cross-sectional research: a critical perspective, use cases, and recommendations for IS research," *International Journal of Information Management*, vol. 70, p. 102625, Jun. 2023, doi: 10.1016/j.ijinfomgt.2023.102625.
[26] L. Huang and A. A. Musah, "The influence of augmented reality on creativity, student behavior, and pedagogical strategies in technology-infused education management," *Journal of Pedagogical Research*, vol. 8, no. 2, pp. 260–275, Apr. 2024, doi: 10.33902/JPR.202425376.
[27] A. S. Gill *et al.*, "Enhancing learning in design for manufacturing and assembly: the effects of augmented reality and game-based learning on student's intrinsic motivation," *Interactive Technology and Smart Education*, vol. 22, no. 1, pp. 61–80, Jan. 2025, doi: 10.1108/ITSE-11-2023-0221.
[28] M. Manna, "Teachers as augmented reality designers: A study on Italian as a foreign language teacher perceptions," *International Journal of Mobile and Blended Learning*, vol. 15, no. 2, pp. 1–16, Mar. 2023, doi: 10.4018/IJMBL.318667.
[29] M. Nijhawan, N. Sindhwani, S. Tanwar, and S. Kumar, "Evaluating barriers to the adoption of augmented reality-based applications in education system: DEMATEL approach," *Journal of Computer Science*, vol. 21, no. 10, pp. 2469–2481, Oct. 2025, doi: 10.3844/jcssp.2025.2469.2481.
[30] X. F. Lin *et al.*, "Teacher learning community for AR-integrated STEM education," *Teaching and Teacher Education*, vol. 141, p. 104490, Apr. 2024, doi: 10.1016/j.tate.2024.104490.
[31] C. Wyss and K. Bäuerlein, "Augmented reality in the classroom—mentor teachers' attitudes and technology use," *Virtual Worlds*, vol. 3, no. 4, pp. 572–585, Dec. 2024, doi: 10.3390/virtualworlds3040029.

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