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Integrating TAM and PACK to Explain Students' Acceptance of History Education Learning Media Across Urban and Rural Schools

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Abstract

This study integrates the Technology Acceptance Model (TAM) and Pedagogical–Technological–Content Knowledge (PACK) to explain students' acceptance of history education learning media across urban and rural school contexts. The participants were 1,179 senior high school students from 17 schools who completed a questionnaire measuring twelve TAM–PACK indicators and their experiences with seven categories of history learning media, generating 8,246 response entries. Data were analyzed using descriptive and comparative statistics, Confirmatory Factor Analysis (CFA), and Structural Equation Modeling (SEM). The descriptive findings reveal that audiovisual media are the most frequently used learning resources in both urban and rural schools, while rural schools remain more dependent on print-based media. The CFA results confirm that all constructs, including Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Attitude toward Use (ATT), Behavioral Intention (BI), and PACK, demonstrate strong convergent and discriminant validity as well as high internal reliability. The TAM–PACK structural model demonstrates a good fit, with PACK significantly affecting PEOU and PU, which subsequently influence students' attitudes toward media use and their behavioral intentions. PACK emerges as the strongest predictor of PEOU and PU, whereas attitude toward use is the primary determinant of behavioral intention. These findings indicate that students' acceptance of history learning media is strongly influenced by the quality of pedagogical, technological, and content integration implemented by teachers as well as differences in school infrastructure. This study provides empirical evidence to inform teacher professional development and technology integration policies that are responsive to urban–rural disparities.

Introduction

Technological developments in education are advancing rapidly and influencing how teachers and students interact with knowledge. The integration of digital media into learning processes offers opportunities to create more interactive, multimodal, and context-rich learning experiences compared with traditional text-based instruction. Several studies indicate that the use of online platforms, digital learning environments, and web-based learning resources contributes to enhancing digital literacy, student engagement, and learning flexibility across educational levels (Colton et al., 2024; Sánchez-Cruzado et al., 2021). In the context of history education, technologies such as virtual reality, interactive simulations, and digital media based on cultural heritage sites can help students build a more comprehensive understanding of past events and local cultural values that must be preserved (Gómez-Trigueros et al., 2019; Lyu & Park, 2025).

However, the use of technology-based history learning media does not always proceed smoothly. Several studies highlight limitations in access, content appropriateness, and teachers' digital competence as factors that may hinder the effective use of digital media in history instruction (Ali & Nadjamuddin, 2017; Desmaryani et al., 2024; Ijirana & Nadjamuddin, 2019; Nadjamuddin, 2023). At the same time, new challenges emerge regarding how to ensure that historical narratives presented through digital media remain authentic, aligned with local cultural values, and not merely replicas of printed materials

reformatted into multimedia (Cassar et al., 2025; Manlee & Kasemsarn, 2025; Sebastián-Rivera et al., 2025). These conditions underscore the importance of designing history learning media that are not only visually engaging but also pedagogically robust and sensitive to socio-cultural contexts.

To explain why some students and teachers accept or reject technology for history learning, many studies refer to the Technology Acceptance Model (TAM) and its variants. This model posits that perceived usefulness and perceived ease of use are key determinants of users' attitudes, intentions, and actual use of technology (Hu et al., 2025; H. Li et al., 2016; Liu et al., 2025). Recent findings also show that factors such as institutional support, prior learning experiences, and the readiness of digital infrastructure can influence the relationship between perceptions and technology-use behaviors in classrooms (Abdi et al., 2025; Mulders et al., 2025; Özgün & Saritepeci, 2021; Wangdi et al., 2023).

Nevertheless, the success of technology integration in education depends not only on technological acceptance but also on teachers' pedagogical capacities to design meaningful learning experiences. The Technological Pedagogical Content Knowledge (TPACK/PACK) framework positions teachers' knowledge of content, pedagogy, and technology as a crucial foundation for effectively using digital media (Ciriza-Mendívil et al., 2022; Gómez-Trigueros et al., 2019; Karlsson & Nilsson, 2023). Research on TPACK shows that teachers with strong technological–pedagogical–content competence are better able to adapt digital media to subject characteristics, including history, and to students' learning needs (Kasi et al., 2022; Tadeko et al., 2024; Tadeko & Wilujeng, 2024; Wilujeng et al., 2020; Zaky et al., 2024). Conversely, weak competence in this area often results in superficial use of digital media that is poorly integrated with learning objectives.

Recent studies increasingly encourage the simultaneous integration of TAM and TPACK to obtain a more comprehensive understanding of educational technology adoption. This integrative approach seeks to link technological–pedagogical–content competence with perceptions of usefulness, ease of use, and other psychological factors that explain intentions and behaviors in technology use (Cheng et al., 2024; Ding et al., 2025; Lyu & Park, 2025). Yet, most of these studies focus on STEM or language subjects, and few have examined history education specifically. In addition, studies that compare social contexts, such as urban and rural schools, remain limited, even though disparities in infrastructure, school culture, and access to digital media may significantly shape patterns of technology acceptance.

Consequently, several gaps remain to be addressed. First, there is a lack of studies that integrate TAM and TPACK into a single structural model to explain students' acceptance of history learning media, particularly when used across a wide range of digital formats. Second, few studies compare technology acceptance patterns between students in urban and rural schools within the context of history education, leaving the influence of social context on relationships among latent variables insufficiently mapped (Abdi et al., 2025; Ali & Nadjamuddin, 2017; Sánchez-Cruzado et al., 2021). Third, detailed mapping of students' preferences for specific types of history media, such as documentary videos, historical films, augmented-reality resources based on local sites, and other interactive media, and their relationships with perceived usefulness, ease of use, and teachers' pedagogical readiness has rarely

been conducted simultaneously within a single empirical framework (Chen et al., 2025; Desmaryani et al., 2024; Gutiérrez-Aguilar et al., 2023; Nadjamuddin et al., 2024).

In response to these gaps, this study aims to develop and test an integrative TAM–PACK model to explain students' acceptance of various types of history learning media across urban and rural school contexts. Specifically, this research: (1) maps students' preferences for different history learning media in the two regional contexts; (2) examines the measurement model validity of key TAM and PACK/TPACK constructs; and (3) analyzes the relationships among latent variables to explain students' intentions to use technology-based history learning media. The theoretical contribution of this study lies in extending the literature on TAM–TPACK integration within history education, while its practical contribution provides an empirical foundation for designing teacher professional development programs and technology integration policies that are more sensitive to the social and cultural contexts of schools.

Literature Review

The Technology Acceptance Model (TAM) has been extensively used to explain users' acceptance of technology in educational settings. Originally proposed by Davis (1989), TAM posits that Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) directly influence users' attitudes toward technology use, which subsequently shape behavioral intention and actual usage (Davis, 1989). In education, TAM has been applied to examine students' and teachers' acceptance of learning management systems, digital media, and technology-enhanced instructional tools (Abdulrasul et al., 2023; Abuhassna et al., 2023; Antonietti et al., 2022). Empirical findings consistently demonstrate that when learners perceive educational technology as useful and easy to use, they are more likely to develop positive attitudes and intentions toward its adoption (Berbar, 2023; Le et al., 2022). Consequently, TAM provides a robust theoretical foundation for analyzing technology acceptance in formal learning environments.

Pedagogical–Technological–Content Knowledge (PACK) Framework

The Pedagogical–Technological–Content Knowledge (PACK) framework, introduced by Mishra and Koehler (2006), emphasizes the integration of pedagogy, technology, and subject matter as the core of effective technology-enhanced teaching (Mishra & Koehler, 2006). PACK extends Shulman's concept of Pedagogical Content Knowledge by explicitly incorporating technological knowledge, arguing that effective instruction emerges from the dynamic interaction among these three domains rather than from their isolated application (Akram et al., 2021). Numerous studies have confirmed that teachers with strong PACK are better able to design meaningful learning experiences, select appropriate media, and align technology use with curricular goals (Dikmen & Demirer, 2022; Mgeladze et al., 2024; Santos & Castro, 2021). Therefore, PACK serves as a critical lens for understanding how instructional quality influences learners' engagement with educational media.

Integrating TAM and PACK in Educational Research

Recent research suggests that integrating TAM and PACK offers a more comprehensive explanation of technology acceptance in education (Al-Abdullatif, 2024; M. Li et al., 2024; Sundararasan, 2024). While TAM focuses on users' perceptions and behavioral intentions, PACK highlights the instructional conditions under which technology is implemented (Runge et al., 2025). Studies integrating both models reveal that teachers' PACK significantly influences learners' perceptions of usefulness and ease of use, thereby strengthening TAM's explanatory power (Ke & Gong, 2025; Park et al., 2025). This integration underscores that students' acceptance of learning media is not solely determined by technological features, but also by how well technology is pedagogically and contextually embedded in instruction. Thus, TAM–PACK integration enables a more holistic understanding of technology acceptance processes.

History Education Learning Media and Student Acceptance

In history education, learning media play a crucial role in supporting conceptual understanding, historical thinking, and learner engagement. The use of audiovisual media, digital simulations, and interactive resources has been shown to enhance students' motivation and comprehension of abstract historical concepts (Belyaev & Belyaeva, 2023). However, research indicates that acceptance of such media varies depending on instructional design and contextual factors (Al-Maroof et al., 2022; Alhumaid et al., 2022). When history learning media are aligned with pedagogical objectives and content structure, students tend to perceive them as more useful and easier to use (Issayev & Apendiyev, 2025). Accordingly, examining history learning media through the integrated TAM–PACK framework allows for deeper insight into how instructional quality shapes student acceptance.

Urban–Rural Contexts and Technology Integration

Educational contexts, particularly differences between urban and rural schools, significantly influence technology integration and acceptance. Urban schools generally benefit from better infrastructure, greater access to digital resources, and higher exposure to technology-rich learning environments (Kormos & Sherman, 2023; Supardi et al., 2024). In contrast, rural schools often face limitations related to infrastructure, connectivity, and availability of learning media (Mhlana et al., 2021). Previous studies show that these contextual disparities affect both instructional practices and students' technology acceptance (McLaren et al., 2022). Therefore, a multi-context analysis across urban and rural settings is essential to capture how contextual conditions interact with TAM and PACK variables in shaping students' acceptance of history learning media.

Methodology

Research Design

This study employed a quantitative approach with a cross-sectional survey design. The primary focus was to test an integrative structural model that combines the Technology Acceptance Model (TAM) and Pedagogical–Technological–Content Knowledge (PACK) to explain students' acceptance of history learning media. The conceptual model tested in this study, presented in Fig. 1, positions PACK as a predictor of perceived ease of use (PEOU) and perceived usefulness (PU), which subsequently influence students' attitudes toward use (ATT) and behavioral intention (BI) regarding history learning media.

The research design aimed to capture variations in students' preferences and acceptance of seven categories of history learning media: print media, static visual media, audio media, audiovisual media (e.g., films and documentary videos), interactive multimedia, augmented reality-based media, and other digital or virtual environments used in history instruction. Thus, the survey design not only assessed general levels of technology acceptance but also linked teachers' use of various media types with students' perceptions, attitudes, and intentions as modeled in the TAM–PACK framework.

Research Participants and Sampling Technique

The study involved 1,179 senior high school students enrolled in history courses across 17 schools located in two regional categories: urban and rural. These categories were selected due to potential differences in technological access, availability of learning media, and levels of digital readiness. Stratified cluster sampling was employed; first, schools were grouped by region (urban and rural), and then schools within each stratum were selected using cluster sampling. All students attending history classes in selected schools were invited to participate under principles of voluntary participation and confidentiality. Each respondent completed a questionnaire containing twelve statements related to the acceptance and use of seven types of history learning media, assessed on a 1–7 Likert scale. This yielded a large dataset (8,246 response entries) representing diverse media-use patterns and levels of technology acceptance across the two social contexts.

Research Instrument

The instrument comprised twelve core indicators representing four TAM constructs and four indicators of PACK integration. These were developed based on the theoretical foundations of Davis (1989), Mishra and Koehler (2006), Shulman (1986, 1987), as well as recent research on history education and digital technology (2019–2025). All indicators were aligned with items validated through a TAM–TPACK Validation Sheet to ensure clear conceptual and empirical grounding.

Table 1
Structure of TAM–PACK instrument items based on recent theoretical frameworks

Item No.	Construct	Conceptual Meaning	Theoretical References
1	Perceived Usefulness (PU1)	Assesses the extent to which media help students understand lessons, accelerate learning, and increase motivation.	(Davis, 1989; Gómez-Trigueros et al., 2019; Nadjamuddin et al., 2024)
7	Perceived Usefulness (PU2)	Measures how far media help students understand historical facts and concepts and connect them to real-life contexts.	(Davis, 1989; Ortega-Sánchez & Gómez-Trigueros, 2019; Sebastián-Rivera et al., 2025)
2	Perceived Ease of Use (PEOU1)	Assesses the ease with which students use the media: easy to learn, clear display, and not confusing.	(AlYoussef, 2020; Davis, 1989; Duche-Pérez et al., 2024)
9	Perceived Ease of Use (PEOU2)	Measures the appropriateness of technology used in the media and how it facilitates understanding of historical content.	(Hetharion et al., 2025; Venkatesh & Davis, 2000)
3	Attitude Toward Use (ATT1)	Describes students' enjoyment and positive views of using media in history learning.	(Ajani et al., 2025; Sembiring et al., 2024; Tripoulas & Koutromanos, 2024)
10	Attitude Toward Use (ATT2)	Assesses the extent to which media make students more active, more motivated, and support online learning.	(Dong, 2025; Mulders et al., 2025; Pan, 2023)
4	Behavioral Intention (BI1)	Measures students' intention to continue using media in future history learning.	(Salloum et al., 2021; Venkatesh & Bala, 2008)
12	Behavioral Intention (BI2)	Evaluates whether media align with course needs and encourage sustained use.	(Ajani et al., 2025; Berger, 2025)
5	PACK Integration (PACK1)	Assesses students' belief that they can learn effectively using both simple tools and digital technologies.	(Ciriza-Mendívil et al., 2022)
6	PACK Integration (PACK2)	Measures how well media support teachers' instructional methods and classroom needs.	(Sánchez-Cruzado et al., 2021; Shulman, 1986)
8	PACK Integration (PACK3)	Assesses how far media help explain complex historical topics in accessible ways.	(Ortega-Sánchez & Gómez-Trigueros, 2019)
11	PACK Integration (PACK4)	Evaluates the degree to which media integrate technology, pedagogy, and historical content.	(Díaz-Noguera et al., 2023; Mishra & Koehler, 2006; Zaky et al., 2024)

Data Collection Procedures

Data were collected using two modes, online and offline questionnaires, selected based on the schools' infrastructure conditions. In schools with adequate internet access, students completed the questionnaire online in classrooms or computer laboratories under teacher supervision. In schools with limited digital facilities, printed questionnaires were distributed and collected after completion under the guidance of history teachers. All returned questionnaires were checked for completeness and consistency; incomplete responses or those showing irregular answer patterns were excluded from analysis. After data cleaning, no missing values were found in the indicators used. Initial distribution checks were conducted to confirm the suitability of the data for further analysis.

The initial analysis was descriptive comparative, mapping the types of history learning media used by teachers based on students' perceptions and comparing usage patterns between urban and rural schools. Frequencies and percentages for each media category were calculated to identify dominant media, emerging media, and those rarely used. These comparisons provided an important contextual backdrop for interpreting the structural modeling results, as variations in infrastructure, school policies, and learning culture may influence perceptions of ease of use, usefulness, and students' intentions to use history learning media.

Measurement Model and Structural Model Analysis

Advanced analysis involved Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM). In the CFA stage, measurement models for PU, PEOU, ATT, BI, and PACK were tested to ensure that each indicator consistently reflected its respective latent construct. Criteria included adequate factor loadings, average variance extracted (AVE) values above 0.50 as evidence of convergent validity, and composite reliability (CR) values above 0.70 as indicators of internal consistency. Discriminant validity was assessed by comparing the square root of AVE with inter-construct correlations. After the measurement model met all validity and reliability requirements, SEM was conducted to test the causal relationships in the TAM–PACK model, specifically the effects of PACK on PEOU and PU, and the effects of these two constructs on ATT and BI. Model fit was evaluated using chi-square/df, CFI, TLI, RMSEA, and SRMR. Path coefficients were examined to assess the significance and strength of relationships among constructs in explaining students' intentions to use technology-based history learning media.

Results and Findings

Data Quality and Fitness for Analysis

Preliminary analyses were conducted to ensure that the dataset met the requirements for SEM. Examination of data completeness indicated that no missing values were present for any indicator. All respondents completed the instrument in full; therefore, no imputation procedures were necessary. No extreme outliers were detected, although several low-variance response patterns were maintained on the basis that they reflected genuine response tendencies rather than noise.

Table 2
Data Completeness Check

Description	Total	Percentage
Total Responses Received	8,246	100%
Incomplete Data	0	0%
Data Eligible for Analysis	8,246	100%

A normality test was also conducted to ensure that the distribution of data met the assumptions for CFA and SEM. Skewness and kurtosis values for all items fell within the acceptable range of ± 2, indicating univariate normality.

Table 3
Summary of normality test (skewness and kurtosis)

Indicator	Skewness	Kurtosis
PU1	−0.880	−0.253
PEOU1	−0.916	−0.225
ATT1	−0.859	−0.280
BI1	−0.875	−0.285

All values fall within the acceptable thresholds recommended by Curran et al. (1996).

Types of History Learning Media

In accordance with the analytical framework, seven types of history learning media were examined: print, visual, audio, audiovisual, interactive multimedia, AR/VR, and local media. Descriptive findings show that audiovisual media are the most widely used by students. Visual media and interactive multimedia follow, while AR/VR remains less frequently used due to limited device availability in many schools.

These variations provide an important contextual backdrop for interpreting how student perceptions of ease of use (PEOU) and usefulness (PU) are shaped through their learning experiences.

Comparison of Media Preferences: Urban vs. Rural Schools

To explore regional variations in media use, analyses were conducted separately for students in urban and rural schools. The results reveal distinct usage patterns aligned with existing research on technological readiness.

Table 4
Ranking of history learning media by region

Rank	Urban (N = 4,592)	Score	Rural (N = 3,654)	Score
1	Audiovisual	5.71	Audiovisual	5.95
2	Visual	5.69	Visual	5.63
3	Interactive Multimedia	5.69	Print Media	5.36
4	Audio	5.46	Interactive Multimedia	5.28
5	VR/AR	5.39	Audio	5.05

Print media rank significantly higher in rural schools, whereas interactive multimedia is more prevalent in urban settings. These findings support the assumption that infrastructure limitations and device availability influence the types of media students encounter.

Measurement Model Results (CFA)

The measurement model for the TAM–PACK constructs was tested using Confirmatory Factor Analysis. All indicators demonstrated strong convergent validity, with high factor loadings, AVE values exceeding 0.50, and composite reliability values above 0.70. This confirms that PU, PEOU, ATT, BI, and PACK were measured reliably and consistently.

Table 5
Convergent validity and construct reliability

Construct	Loading Range	AVE	CR
PACK	0.884–0.917	0.821	0.948
PU	0.883	0.780	0.876
PEOU	0.912	0.831	0.908
ATT	0.859	0.738	0.850
BI	0.854	0.730	0.844

Discriminant validity was also confirmed using the Fornell–Larcker criterion.

Table 6
Discriminant validity (square root of AVE on the diagonal)

Construct	PACK	PEOU	PU	ATT	BI
PACK	**0.906**				
PEOU	0.652	**0.912**			
PU	0.625	0.511	**0.883**		
ATT	0.583	0.537	0.612	**0.859**	
BI	0.544	0.498	0.587	0.748	**0.854**

Since the diagonal values exceed inter-construct correlations, discriminant validity is established.

Structural Model Results (SEM)

After the measurement model satisfied all criteria, SEM was conducted to examine relationships among latent variables in the TAM–PACK model. The model demonstrated excellent fit.

Table 7
Model goodness-of-fit indices

Indicator	Value	Criterion	Interpretation
RMSEA	0.062	< 0.08	Good Fit
CFI	0.964	> 0.90	Good Fit
TLI	0.958	> 0.90	Good Fit
SRMR	0.045	< 0.08	Good Fit

All hypothesized paths in the model were found to be significant.

Table 8
Path coefficients

Path	β	P-Value	Status
PACK → PEOU	0.948	0.000	Significant
PACK → PU	0.799	0.000	Significant
PEOU → PU	0.139	0.000	Significant
PU → ATT	0.483	0.000	Significant
PEOU → ATT	0.437	0.000	Significant
ATT → BI	0.875	0.000	Significant

The path coefficients indicate that PACK is the strongest predictor in the model, while attitude is the principal determinant of behavioral intention.

Overall, the findings reveal coherent relationships between descriptive data, regional context, media-use patterns, and the TAM–PACK structural relationships. Audiovisual media dominate in both regions, while rural schools rely more heavily on print media. These disparities indirectly shape perceptions of ease of use and usefulness, which subsequently influence attitudes and intentions to use technology. The conceptual model is empirically validated and demonstrates strong predictive capability.

Discussion

This section discusses the main findings of the study in relation to the literature on technology acceptance and pedagogical–technological–content competence in history education. Broadly, three key aspects are addressed: (1) the role of PACK as a foundation for technology acceptance within the TAM framework; (2) the position of perceived ease of use and perceived usefulness, as well as students' attitudes, as mediators leading to the intention to use history learning media; and (3) the implications of media variety and urban–rural contextual differences for technology acceptance.

1. The Central Role of PACK in the TAM Model for History Education

The structural modelling results indicate that PACK has a substantial and significant effect on perceived ease of use (PEOU) and perceived usefulness (PU). This finding confirms the idea that teachers' pedagogical–technological–content competence is not merely an additional factor, but a foundational element shaping how students interpret the ease and usefulness of history learning media. Teachers who can integrate historical content, pedagogical strategies, and technology coherently tend to create learning experiences that are structured, clear, and relevant for students, making the technology appear more effortless to use and more beneficial from the students' perspective (Ciriza-Mendívil et al., 2022; Gómez-Trigueros et al., 2019; Karlsson & Nilsson, 2023; Niess, 2014).

This finding is consistent with studies showing that teachers' TPACK competence correlates with the quality of technology-based instructional design and student engagement. Research in science, primary education, and higher education contexts has demonstrated that when teachers understand how to align technological features with learning objectives and content characteristics, students report more meaningful learning experiences rather than merely "replacing the blackboard with a screen" (Kasi et al., 2022; Tadeko & Wilujeng, 2024; Wilujeng et al., 2020; Zaky et al., 2024). In history education, strong PACK enables teachers to present past events narratively, using digital sources, films, and simulations in ways that stimulate critical thinking and historical empathy, rather than simply showing videos as entertainment or interludes (Ortega-Sánchez & Gómez-Trigueros, 2019; Sebastián-Rivera et al., 2025).

Thus, the present findings extend existing evidence by showing that TPACK/PACK is relevant not only for explaining how teachers design instruction, but also for how students construct their perceptions of the technology itself. PACK functions as a bridge between the potential of technology and the concrete

learning experiences in the classroom. Without adequate PACK, even technically sophisticated history media may not be perceived by students as easy to use or helpful.

2. Ease of Use, Usefulness, and Attitudes as Pathways to the Intention to Use History Media

The SEM results also show that PEOU influences PU, and that both directly and indirectly shape positive attitudes toward the use of history learning media. These attitudes, in turn, significantly contribute to students' behavioral intention to reuse and take advantage of technology-based history media. This pattern is in line with numerous studies employing TAM and its extensions to explain technology acceptance in education, both among teachers and students (Amhimmid et al., 2025; Hou, 2025; Hu et al., 2025; H. Li et al., 2016).

In this context, PEOU can be understood as a direct outcome of well-structured instructional design and clear guidance on media use in the classroom. When teachers reduce technical barriers by providing scaffolding, step-by-step instructions, or intuitive interface designs, students can operate the media more easily and are less likely to feel "left behind" technologically (Nachtigall et al., 2024; Sánchez-Cruzado et al., 2021; Wangdi et al., 2023). As technical barriers decrease, students' cognitive resources can be redirected from "how to operate the media" to "what can be learned from the media." This helps to explain why PEOU emerges as an essential predictor of PU in this study.

Meanwhile, PU relates to the extent to which students perceive that the media genuinely help them to understand historical content, connect past events with contemporary contexts, and foster interest in historical issues. Previous research has shown that perceived usefulness is one of the most consistent predictors of attitudes and intentions to use technology across domains, from mathematics and language learning to adaptive systems and metaverse environments (Cheng et al., 2024; Luik & Taimalu, 2021; Lyu & Park, 2025; Mokhtar et al., 2025). The present findings affirm this pattern in the context of history education and underscore that positive attitudes toward history media develop when students experience cognitive and affective benefits, rather than merely entertainment.

The fact that attitudes (ATT) are a strong predictor of behavioral intention (BI) is also consistent with TAM-based research in education, including among teachers adopting new technologies, learners in online classes, and users of virtual environments (Al-Adwan et al., 2024; Mulders et al., 2025; Sustaningrum & Haldaka, 2025). In this study, positive attitudes are reflected in students' willingness to reuse digital history media, explore additional materials beyond class time, or recommend similar media for other subjects. This reinforces the argument that the proposed integrative TAM–PACK model can explain the cognitive–affective pathways linking learning experiences to students' behavioral intentions.

3. Varieties of History Media and Urban–Rural Contextual Differences

The descriptive findings indicate that audiovisual media, particularly historical films and documentary videos, are the most frequently used and most salient category in students' perceptions in both urban and rural schools. This supports earlier research highlighting the potential of film and video as powerful

tools in history education, as they can present past events visually and narratively, stimulate empathy, and help students construct historical imagination (Repoussi & Mavrommati, 2022). In many cases, audiovisual media serve as a "first gateway" that sparks students' interest in exploring other historical sources, such as written documents, digital archives, or local sites.

However, the use of interactive multimedia, augmented reality (AR)-based media, and virtual environments appears to be uneven. In urban schools, these media have begun to be introduced and used to enrich learning experiences, whereas in rural schools their use remains relatively limited. This pattern aligns with literature highlighting infrastructural and technological readiness gaps between contexts with high and low digital access, both in Indonesia and elsewhere (Abdi et al., 2025; Ali & Nadjamuddin, 2017; Desmaryani et al., 2024; Ijirana & Nadjamuddin, 2019). At the same time, research on local-site-based history learning shows that when local historical resources are creatively integrated through digital media (e.g., AR or virtual tours of heritage sites), students tend to show increased knowledge of local history and a stronger sense of identity (Nadjamuddin et al., 2024; Sebastián-Rivera et al., 2025).

The differences observed between urban and rural schools in this study underline that technology acceptance is always contextual. In ecosystems supported by school policies, digital infrastructure, and a pro-technology learning culture, newer media such as VR, AR, and collaborative digital platforms are more easily adopted and accepted (T. Li et al., 2025; Mulders et al., 2025; Mulyani et al., 2025). Conversely, in contexts with limited access, teachers and students tend to maximize the use of relatively simpler yet consistently available media such as films, videos, and printed modules. Within the TAM–PACK framework, these contextual factors can modify the relationships between PACK, PEOU, PU, and behavioral intention, suggesting the importance of further studies that explicitly model school context as a moderating factor.

4. Theoretical Contributions

Theoretically, this study offers several contributions. First, it integrates TAM and PACK into a single structural model empirically tested with a large sample in the context of history education. Unlike many prior studies that focus either on teachers' TPACK or on technology acceptance in isolation (Gómez-Trigueros et al., 2019; Karlsson & Nilsson, 2023; N. Li et al., 2024; Mailizar et al., 2021), this research demonstrates how teachers' pedagogical–technological–content competence is connected to students' perceptions and attitudes toward history media. PACK is thus positioned not only as a teacher attribute but also as a variable with implications for students' technology acceptance pathways.

Second, this study foregrounds history education as the primary context, whereas many previous TAM–TPACK studies have focused on STEM, language learning, or higher education more generally (Abuhassna et al., 2023; Cheng et al., 2024; Wilujeng et al., 2020). By attending to varieties of history media and urban–rural differences, this research extends the empirical scope of technology acceptance literature into a domain that is rich in cultural and political significance, namely history education. Third, the detailed mapping of historical media and students' preferences adds to ongoing discussions on how

digital representations of the past (e.g., films, historical games, VR simulations, and AR based on local sites) shape the ways students interpret historical worlds (Kebir et al., 2025; Townsend, 2022; Wu et al., 2023).

5. Practical Implications

The findings have practical implications for teachers, curriculum developers, and policymakers. For teachers, the results highlight the importance of continuously developing PACK competence. Training on technology integration in history education needs to go beyond the technical aspects of using devices. It should encompass the design of learning scenarios that use historical media to foster deep understanding, critical thinking, and sensitivity to contemporary historical issues (Alomyan & Alelaimat, 2021; Tadeko & Wilujeng, 2024; Wilujeng et al., 2024).

For policymakers at the school and system levels, the findings indicate that investments in technological infrastructure must be accompanied by systematic support for the enhancement of teachers' pedagogical–technological–content competence. Without strong PACK, digital devices and platforms risk being underutilised and may not lead to substantial increases in students' technology acceptance (Al-Adwan et al., 2024; Anwar et al., 2025; Desmaryani et al., 2024). Furthermore, the observed differences between urban and rural schools suggest the need for affirmative policies that address gaps in access and support, so that students in rural areas are not left behind in terms of digital literacy and technology-based history learning experiences.

6. Limitations and Recommendations for Future Research

Despite involving a large sample and employing robust structural analysis techniques, this study has several limitations. First, the cross-sectional survey design does not fully allow for causal inferences, even though the conceptual model was theoretically grounded. Future studies using longitudinal or quasi-experimental designs could provide a stronger picture of how perceptions and intentions to use historical media change over time (Garcia et al., 2024; M. Li et al., 2025). Second, although the variety of history media has been mapped, this study did not analyse separately the effects of each specific type of media (e.g., documentary films, virtual tours, AR based on local sites, historical games, and interactive multimedia) on the TAM–PACK variables.

Future research could test more media-specific technology acceptance models and explore the roles of additional psychological factors such as self-regulation, enjoyment, or cognitive load in digital history learning (Lyu & Park, 2025; Nachtigall et al., 2024). In addition, qualitative studies that examine students' and teachers' narratives about their experiences with digital history media could complement the quantitative findings, particularly regarding how they interpret representations of the past and the implications for historical consciousness and citizenship.

Overall, this discussion shows that students' acceptance of technology-based history learning media is the result of a complex interaction between teachers' PACK competence, perceptions of ease of use and

usefulness, attitudes toward technology use, and the social–institutional context in which learning takes place. The integrative TAM–PACK model tested in this study offers a promising framework for understanding and developing history teaching practices in the digital era.

Conclusion

This study concludes that the integrative TAM–PACK model is effective in explaining students' acceptance of technology-based history learning media across two distinct regional contexts. All latent constructs, PU, PEOU, ATT, BI, and PACK, were shown to be valid and reliable, with the structural model demonstrating excellent fit. The strong relationships between PACK and both PEOU and PU, which subsequently influence the formation of positive attitudes and behavioral intentions, indicate that teachers' pedagogical–technological–content competence serves as a fundamental basis for students' perceptions of ease of use, perceived usefulness, and their willingness to continue using digital history media.

The descriptive and structural findings collectively reveal that audiovisual media constitute a common point of technological acceptance in both urban and rural schools. In contrast, the greater reliance on print media in rural schools reflects infrastructural and device-access limitations. This suggests that strategies to expand innovation in history learning media should begin with strengthening inclusive audiovisual-based instructional design and gradually extending to interactive multimedia, VR/AR, and other digital environments according to each school's level of readiness.

Theoretically, this study advances the application of TAM and PACK in the context of history education by positioning PACK not only as an attribute of teachers, but also as a primary driver in the sequence of students' technology acceptance processes—from perceptions of ease and usefulness to attitudes and intentions to use media. Practically, the findings affirm that the most strategic investment for schools and policymakers lies in developing teachers' capacity to integrate technology, pedagogy, and historical content, rather than merely increasing the number of devices. Building on these findings, teacher professional development programs and technology integration policies can be designed to be more responsive to urban–rural disparities and to support the creation of meaningful and equitable digital history learning experiences for all students.

Declarations

Ethics approval and consent to participate

The research protocol was reviewed and approved by the Research Ethics Committee of Universitas Tadulako, Palu, Central Sulawesi, Indonesia, under approval number 1272/DST/UN28.16/AL.02.01/2026. The study was conducted in accordance with the ethical standards of the responsible institutional research ethics committee, relevant national guidelines and regulations, and the principles of the Declaration of Helsinki. Participation was voluntary, and the confidentiality and anonymity of all participants were maintained throughout the study. Informed consent was obtained from all participants

aged 16 years or above prior to their participation in the study. For participants under 16 years of age, informed consent was obtained from their parents or legal guardians prior to participation.

Consent for Publication

Not applicable. This study does not contain any identifiable images, case details, or personal data belonging to an individual person; only anonymized, aggregated survey responses were analyzed.

Availability of data and materials

The datasets generated and analyzed during the current study are not publicly available due to ethical considerations and the need to protect the privacy and confidentiality of the student participants. However, anonymized data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to applicable ethical and institutional requirements.

Competing interests

The authors declare that they have no competing interests.

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Author Contributions

LN conceived and designed the study, coordinated the research project, supervised data collection, and contributed to drafting the manuscript. IR contributed to the study design, conceptual framework development, data interpretation, and critical review of the manuscript. NT contributed to the research methodology, data analysis, the development of the TAM–PACK conceptual framework, implementation of Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM), and interpretation of the statistical findings. MZ supported data collection, data validation, and manuscript preparation and revision. BN contributed to interpretation of the statistical findings, manuscript drafting, and critical review and final editing of the manuscript. All authors read and approved the final manuscript.

Declaration of Generative AI Use

The authors used ChatGPT solely to support language editing and improve the clarity of the manuscript. All AI-assisted content was carefully reviewed and revised by the authors, who retain full responsibility for the accuracy and final content of the manuscript.

References

1. Abdi A-NM, Omar AM, Ahmed MH, Ahmed AA. The predictors of behavioral intention to use ChatGPT for academic purposes: evidence from higher education in Somalia. Cogent Educ. 2025;12(1):2460250. https://doi.org/10.1080/2331186X.2025.2460250.
2. Abdulrasul AH, Sallabi OM, Elaish MM. (2023). A Proposed Technology Acceptance Model for Measuring Cloud Computing Usage in Education. 2023 IEEE 11th International Conference on Systems and Control (ICSC), 252–257. https://doi.org/10.1109/ICSC58660.2023.10449841
3. Ajani O, Govender S, Gamede B. Enhancing equitable and accessible learning for undergraduate students at rural universities through learning management systems: Effectiveness, challenges and optimisation. Multidisciplinary Reviews; 2025. https://doi.org/10.31893/multirev.2026098. Accepted Articles.
4. Akram H, Yingxiu Y, Al-Adwan AS, Alkhalifah A. Technology integration in higher education during COVID-19: An assessment of online teaching competencies through technological pedagogical content knowledge model. Front Psychol. 2021;12:736522. https://doi.org/10.3389/fpsyg.2021.736522.
5. Al-Abdullatif AM. Modeling teachers' acceptance of generative artificial intelligence use in higher education: the role of AI literacy, intelligent TPACK, and perceived trust. Educ Sci. 2024;14(11):1209. https://doi.org/10.3390/educsci14111209.
6. Al-Adwan AS, Meet RK, Kala D, Smedley J, Urbaníková M, Al-Rahmi WM. Closing the divide: Exploring higher education teachers' perspectives on educational technology. Inform Dev. 2024;02666669241279181. https://doi.org/10.1177/02666669241279181.
7. Al-Maroof RS, Alahbabi NMN, Akour I, Alhumaid K, Ayoubi K, Alnnaimi M, Thabit S, Alfaisal R, Aburayya A, Salloum S. Students' perception towards behavioral intention of audio and video teaching styles: An acceptance study. Int J Data Netw Sci. 2022;6(2):603. https://doi.org/10.5267/j.ijdns.2021.11.004.
8. Alhumaid K, Alfaisal R, Alnazzawi N, Alfaisal A, Alhumaidhi NN, Alamarin M, Salloum SA. (2022). Predicting the intention to use audi and video teaching styles: an empirical study with PLS-SEM and machine learning models. International Conference on Advanced Machine Learning Technologies and Applications, 250–264. https://doi.org/10.1007/978-3-031-03918-8_23
9. Ali AA, Nadjamuddin L. The integrated approach for identity establishment of donggala city in Indonesia. A/Z ITU. J Fac Archit. 2017;14(3):83–97. https://doi.org/10.5505/itujfa.2017.88598.
10. Alomyan H, Alelaimat A. Employing ICTs in Kindergartens in Remote Areas of Jordan: Teachers' Perspectives on Uses, Importance and Challenges. Eur J Educational Res. 2021;10(4):2145–57. https://doi.org/10.12973/eu-jer.10.4.2145.
11. AlYoussef I. An empirical investigation on students' acceptance of (SM) use for teaching and learning. Int J Emerg Technol Learn (IJET). 2020;15(4):158–78. https://doi.org/10.3991/ijet.v15i04.11660.
12. Amhimmid AM, Benamer WH, Benamer SH. (2025). Evaluating the Effectiveness of Moodle Adoption at a Libyan University Using the Technology Acceptance Model (TAM). 2025 5th

International Conference on Innovative Research in Applied Science, Engineering and Technology (IRASET), 1–7. https://doi.org/10.1109/IRASET64571.2025.11008223

13. Antonietti C, Cattaneo A, Amenduni F. Can teachers' digital competence influence technology acceptance in vocational education? Comput Hum Behav. 2022;132:107266. https://doi.org/10.1016/j.chb.2022.107266.
14. Anwar K, Musa J, Salleh SM. From learning to practice: The role of preparation, acceptance, skills, and innovativeness in affecting preservice teacher technology integration. Educ Inform Technol. 2025;30(7):9041–67. https://doi.org/10.1007/s10639-024-13181-1.
15. Belyaev DA, Belyaeva UP. Digital Game Based Learning in the institutional-academic study of history: theory and practice of learning modality of video game cybertexts. Perspect Sci Educ. 2023;5:686–703. https://doi.org/10.32744/pse.2023.5.40.
16. Berbar S. (2023). User Experience and Technology Adoption: The Mediating Effect of Perceived Ease of Use on Senso-Aesthetic Openness and Behaviour Intention. 2023 17th International Conference on Signal-Image Technology & Internet-Based Systems (SITIS), 38–45. https://doi.org/10.1109/SITIS61268.2023.00016
17. Berger P. (2025). For an Integrated View of Media Education: Media Practices, Their Specific Facets and the Interplay Between Them in Educational Environments. Critical Literacies and Gender Studies: Navigating Media, Education, and Civic Engagement for Social Justice, 17–31. https://doi.org/10.1108/978-1-83662-594-020251002
18. Cassar A, Baker D, Ioannides M. From digital twin to memory twin: a holistic framework for cultural heritage documentation, interpretation, and adaptive reuse. Int Archives Photogrammetry Remote Sens Spat Inform Sci. 2025;48:203–9. https://doi.org/10.5194/isprs-archives-XLVIII-M-9-2025-203-2025.
19. Chen C-H, Su C-Y, Lo F. Experiencing historical events through a VR environment to enhance learning achievement, interest, motivation, and emotional reflections. Interact Learn Environ. 2025;1–18. https://doi.org/10.1080/10494820.2025.2535683.
20. Cheng J, Hall JA, Wang Q, Lei J. More than high, medium, and low: Pre-service teacher TPACK profiles and intentions to teach with technology. Educ Inform Technol. 2024;29(18):24387–413. https://doi.org/10.1007/s10639-024-12793-x.
21. Ciriza-Mendívil CD, Lacambra AM, de la Hernández JM. Technological pedagogical content knowledge: Implementation of a didactic proposal for preservice history teachers. Front Educ. 2022;7:852801. https://doi.org/10.3389/feduc.2022.852801.
22. Colton J, O'Keeffe L, Barry G, White B, White J. Teacher's perceptions of pedagogical practices in innovative learning spaces. Pedagogy Cult Soc. 2024;32(3):675–97. https://doi.org/10.1080/14681366.2022.2073605.
23. Curran PJ, West SG, Finch JF. The robustness of test statistics to nonnormality and specification error in confirmatory factor analysis. Psychol Methods. 1996;1(1):16.

24. Davis FD. Perceived Usefulness, Perceived Ease of Use and User Acceptance of Information Technology. MIS Q. 1989. https://doi.org/10.2307/249008.
25. Desmaryani S, Soleh A, Wiarta I. Integration of technology acceptance models and government support to improve digital literacy. Heliyon. 2024;10(14). https://doi.org/10.1016/j.heliyon.2024.e34086.
26. Díaz-Noguera MD, Martín-Gutiérrez Á, García-Jiménez J, Hervás-Gómez C. Situated Learning and Education: Development and Validation of the Future Teacher Attitudes Scale in the Application of Augmented Reality in the Classroom. Int J Educational Methodol. 2023;9(4):787–99.
27. Dikmen CH, Demirer V. The role of technological pedagogical content knowledge and social cognitive variables in teachers' technology integration behaviors. Participatory Educational Res. 2022;9(2):398–415. https://doi.org/10.17275/per.22.46.9.2.
28. Ding L, Lawson C, Shapira P. Rise of generative artificial intelligence in science. Scientometrics. 2025;130(9):5093–114. https://doi.org/10.1007/s11192-025-05413-z.
29. Dong D. Self-determination theory perspectives on the influence of digital learning engagement on motivation in extracurricular learning activities: Considering the mediating role of digital self-efficacy. Learn Motiv. 2025;90:102135. https://doi.org/10.1016/j.lmot.2025.102135.
30. Duche-Pérez AB, Gutiérrez-Aguilar OA, Vera-Revilla CY, Chicana-Huanca S, Andía-Gonzales BG. The mediating effect of knowledge acquisition on the application of knowledge in interactions: Perceptions of ease of use, actual use, and behavioral intentions in e-learning platforms. Edelweiss Appl Sci Technol. 2024;8(5):2055–69. https://doi.org/10.55214/25768484.v8i5.1949.
31. Garcia JAM, Gomez CG, Lopez AT, Schlosser MJ. Applying the technology acceptance model to online self-learning: A multigroup analysis. J Innov Knowl. 2024;9(4):100571. https://doi.org/10.1016/j.jik.2024.100571.
32. Gómez-Trigueros IM, Ruiz-Bañuls M, Ortega-Sánchez D. Digital literacy of teachers in training: Moving from ICTs (information and communication technologies) to LKTs (learning and knowledge technologies). Educ Sci. 2019;9(4):274. https://doi.org/10.3390/educsci9040274.
33. Gutiérrez-Aguilar O, Duche-Pérez A, León-Lucano J, Córdova-Buiza F, de Manchego VT, Chicaña-Huanca S. (2023). Teaching Skills Mediated by Perceived Utility and Ease of Use in Student Motivation and Collaboration. International Conference on Communication and Applied Technologies, 81–91. https://doi.org/10.1007/978-981-99-7210-4_8
34. Hetharion BDS, Yafie E, Bakri TSM, Ilyas SN, Nirmala B, Setyaningsih D. Using Emerging Digital Technologies Adoption for History Teaching: A Teacher-Centric Unified Theory of Acceptance and Use of Technology Analysis of Motivational and Environmental Influences. Eur J Educational Res. 2025;14(3):999–1014. https://doi.org/10.12973/eu-jer.14.3.999.
35. Hou S. Exploring learner acceptance and experience in MOOCs among higher vocational students from a TAM perspective: a case study of college English course. Front Psychol. 2025;16:1643166. https://doi.org/10.3389/fpsyg.2025.1643166.

36. Hu Y, Xu Y, Wu B. A dual-pathway model of teacher-AI collaboration based on the job demands-resources theory. Educ Inform Technol. 2025;1–22. https://doi.org/10.1007/s10639-025-13421-y.
37. Ijirana, Nadjamuddin L. Time Series Study of Problem Solving Ability of Tadulako University Students Using Metacognitive Skill Based Learning Model. Int J Emerg Technol Learn. 2019;14(21). https://doi.org/10.3991/ijet.v14i21.11684.
38. Issayev M, Apendiyev T. Teaching history with the help of information and digital technologies. E-Learning Digit Media. 2025;20427530251379080. https://doi.org/10.1177/20427530251379080.
39. Karlsson G, Nilsson P. Capturing student teachers' TPACK by using T-CoRe and video-annotation as self-reflective tools for flexible learning in teacher education. Technol Pedagogy Educ. 2023;32(2):223–37. https://doi.org/10.1080/1475939X.2023.2170455.
40. Kasi YF, Widodo A, Samsudin A, Riandi R. The benefits of Teacher Professional Development (TPD) program based on partnership, technology, and ethnoscience approach to improving the TPACK of science teachers. Pedagonal: Jurnal Ilmiah Pendidikan. 2022;6(2):228–37. https://doi.org/10.55215/pedagonal.v6i2.5756.
41. Ke Q, Gong Y. Linking TPACK to teacher self-efficacy in EFL teacher education: Mediating roles of perceived usefulness and perceived ease of use. J Res Technol Educ. 2025;1–24. https://doi.org/10.1080/15391523.2025.2568514.
42. Kebir A, Kacher S, Larabi M-C, Meneveaux D. Engaging Youth in Moorish Architectural Heritage through Virtual 3D Experience of the Bardo Palace of Algiers. ACM J Comput Cult Herit. 2025;18(2):1–19. https://doi.org/10.1145/3718089.
43. Kormos E, Sherman J. Strategies to Facilitate Digital Learning in Urban High-Needs Social Studies Classrooms. Digital Learning in High-Needs Schools. Routledge; 2023. pp. 118–29.
44. Le TMH, Duong TNM, Nguyen TS, Le TTH, Nguyen TTH. Assessing student's adoption of e-learning: An integration of TAM and TPB framework. J Inform Technol Education: Res. 2022;21:297–335. https://doi.org/10.28945/5000.
45. Li H, Xiong Y, Zang X, Kornhaber L, Lyu M, Chung Y, K. S., Suen K, H. Peer assessment in the digital age: A meta-analysis comparing peer and teacher ratings. Assess Evaluation High Educ. 2016;41(2):245–64. https://doi.org/10.1080/02602938.2014.999746.
46. Li M, Vale C, Tan H, Blannin J. Exploring Technological Pedagogical Readiness (TPR) in China's primary mathematics teachers: TPR scale validation. Eurasia J Math Sci Technol Educ. 2024;20(7):em2469. https://doi.org/10.29333/ejmste/14727.
47. Li M, Vale C, Tan H, Blannin J. Factors influencing the use of digital technologies in primary mathematics teaching: Voices from Chinese educators. Educ Inform Technol. 2025;1–36. https://doi.org/10.1007/s10639-024-13309-3.
48. Li N, Lau KL, Liang Y, Chai CS. Pre-service foreign language teachers' TPACK preparation for technology integration: what are the profiles and key drivers? Asia Pac J Educ. 2024;1–17. https://doi.org/10.1080/02188791.2024.2415392.

49. Li T, Hu H, Ma H, Ma J, Li Q. Using Virtual Reality to Enhance Learning Performance and Address Educational Resource Disparities in Architectural History Courses. Sustainability. 2025;17(3):866. https://doi.org/10.3390/su17030866.
50. Liu J, Dai Q, Chen J. Factors affecting teachers' use of digital resources for teaching mathematical cultures: An extended UTAUT-2 model. Educ Inform Technol. 2025;30(6):7659–88. https://doi.org/10.1007/s10639-024-13105-z.
51. Luik P, Taimalu M. Predicting the intention to use technology in education among student teachers: A path analysis. Educ Sci. 2021;11(9):564. https://doi.org/10.3390/educsci11090564.
52. Lyu Z, Park K. The effect of self-regulation and metaverse features on generation Z's adoption of gamified learning platforms. Int J Human–Computer Interact. 2025;41(15):9209–23. https://doi.org/10.1080/10447318.2024.2423338.
53. Mailizar M, Hidayat M, Al-Manthari A. Examining the impact of mathematics teachers' TPACK on their acceptance of online professional development. J Digit Learn Teacher Educ. 2021;37(3):196–212. https://doi.org/10.1080/21532974.2021.1934613.
54. Manlee N, Kasemsarn K. The Authenticity Challenge in Digital and Social Media in Cultural Tourism: A Systematic Literature Review. Heritage. 2025;8(11). https://doi.org/10.3390/heritage8110478.
55. McLaren BM, Richey JE, Nguyen H, Hou X. How instructional context can impact learning with educational technology: Lessons from a study with a digital learning game. Comput Educ. 2022;178:104366. https://doi.org/10.1016/j.compedu.2021.104366.
56. Mgeladze A, Kapanadze M, Chakhaia L. From Measuring to Action: The Next Steps in Physics Teachers' Technological Pedagogical Content Knowledge. Sci Educ Int. 2024;35(4):429–38. https://doi.org/10.33828/sei.v35.i4.13.
57. Mhlana S, Chipangura B, Twinomurinzi H. (2021). Conceptualizing factors that influence learners' intention to adopt ICT for learning in rural schools in developing countries. Proceedings of Sixth International Congress on Information and Communication Technology: ICICT 2021, London, Volume 2, 391–401. https://doi.org/10.1007/978-981-16-2380-6_34
58. Mishra P, Koehler MJ. Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers Coll Record. 2006;108(6):1017–54. https://doi.org/10.1111/j.1467-9620.2006.00684.
59. Mokhtar I, Souar Y, Roucham B, Djelloul C, Lefilef A, Ahmed ER. Distance learning among Algerian students: validating the technology acceptance model (TAM) through comparative study between partial least square and covariance-based structural equation modeling. J Appl Res High Educ. 2025;1–15. https://doi.org/10.1108/JARHE-11-2024-0636.
60. Mulders M, Träg KH, Kaninski L, Rahner L. Past lives, present learners: Future directions for history education in virtual reality. Computers Education: X Real. 2025;7:100114. https://doi.org/10.1016/j.cexr.2025.100114.
61. Mulyani FF, Ningsih TZ, Putri SK. Development of Local History-Based Virtual Reality Media to Improve Practical History Skills. JOIV: Int J Inf Visualization. 2025;9(5):1834–44.

https://doi.org/10.62527/joiv.9.5.2458.

62. Nachtigall V, Yek S, Rummel N. Improving students' processing of history-related 360° videos through collaboration and emotion regulation. J Comput Assist Learn. 2024;40(6):3338–59. https://doi.org/10.1111/jcal.13076.
63. Nadjamuddin L. Development of Historical Melodies to Build Character Profile of Pancasila Students. J Sci Res Educ Technol (JSRET). 2023;2(4):1775–88. https://doi.org/10.58526/jsret.v2i4.295.
64. Nadjamuddin L, Jamaludin J, Rore I, Zaky M, Tadeko N. (2024). Improving Learning Experience Through Augmented Reality Media Workshop Oriented on Local Wisdom at the Megalithic Site of Poso. AURELIA: Jurnal Penelitian Dan Pengabdian Masyarakat Indonesia, 3(2), 1915–1923.
65. Niess ML. (2014). Transforming teachers' knowledge: Learning trajectories for advancing teacher education for teaching with technology. In Technological pedagogical content knowledge: Exploring, developing, and assessing TPCK (pp. 19–37). Springer. https://doi.org/10.1007/978-1-4899-8080-9_2
66. Ortega-Sánchez D, Gómez-Trigueros IM. MOOCs and NOOCs in the training of future geography and history teachers: A comparative cross-sectional study based on the TPACK model. IEEE Access. 2019;8:4035–42. https://doi.org/10.1109/ACCESS.2019.2963314.
67. Özgün Z, Saritepeci M. Determination of the factors affecting teachers' perceptions of classroom management competence in technology assisted courses. Technol Pedagogy Educ. 2021;30(5):673–91. https://doi.org/10.1080/1475939X.2021.1956579.
68. Pan X. Online learning environments, learners' empowerment, and learning behavioral engagement: The mediating role of learning motivation. Sage Open. 2023;13(4):21582440231205096. https://doi.org/10.1177/21582440231205098.
69. Park S-W, Lee S-B, Sung K-J, Teacher-Centered. TAM–TPACK Framew Instructional Des Sustain, 17(23), 10476. https://doi.org/10.3390/su172310476.
70. Repoussi M, Mavrommati M. (2022). Historical Films in History Classrooms: Documentaries or Fiction Films? Teachers' Views and Practices. In History Education in the Digital Age (pp. 197–216). Springer. https://doi.org/10.1007/978-3-031-10743-6_11
71. Runge I, Hebibi F, Lazarides R. Acceptance of pre-service teachers towards artificial intelligence (AI): The role of AI-related teacher training courses and AI-TPACK within the technology acceptance model. Educ Sci. 2025;15(2):167. https://doi.org/10.3390/educsci15020167.
72. Salloum SA, AlAhbabi NMN, Habes M, Aburayya A, Akour I. (2021). Predicting the intention to use social media sites: a hybrid SEM-machine learning approach. International Conference on Advanced Machine Learning Technologies and Applications, 324–334. https://doi.org/10.1007/978-3-030-69717-4_32
73. Sánchez-Cruzado C, Santiago Campión R, Sánchez-Compaña MT. Teacher digital literacy: The indisputable challenge after COVID-19. Sustainability. 2021;13(4):1858. https://doi.org/10.3390/su13041858.

74. Santos JM, Castro RDR. Technological Pedagogical content knowledge (TPACK) in action: Application of learning in the classroom by pre-service teachers (PST). Social Sci Humanit Open. 2021;3(1):100110. https://doi.org/10.1016/j.ssaho.2021.100110.
75. Sebastián-Rivera G, Costa-Tebar F, Gallud JA, Lozano MD, Leporini B, Barba-Sánchez V, Orozco-Barbosa L. Evaluating the Technology Acceptance of MundoCRA: A Virtual Learning Environment for Primary Education. Int J Human–Computer Interact. 2025;1–15. https://doi.org/10.1080/10447318.2025.2474489.
76. Sembiring A, Lubis M, Perdana I, Ramadhan YZ, Permata NA. (2024). Development of Interactive Learning Media Based on Bloom's Taxonomy to Increase Student Engagement and Understanding. 2024 Ninth International Conference on Informatics and Computing (ICIC), 1–6. https://doi.org/10.1109/ICIC64337.2024.10957522
77. Shulman LS. Those who understand: Knowledge growth in teaching. Educational Researcher. 1986;15(2):4–14.
78. Sundararasan T. The behavioural intention of student teachers for online learning after the COVID-19 pandemic: A survey. Citizsh Teach Learn. 2024;19(3):267–83. https://doi.org/10.1386/ctl_00164_1.
79. Supardi S, Agustina T, Muslimin AI. Exploring the role of digital infrastructure in school accreditation across types and geographies. Edelweiss Appl Sci Technol. 2024;8(6):8793–804. https://doi.org/10.55214/25768484.v8i6.3877.
80. Sustaningrum R, Haldaka M. Student utilization and perceptions of AI technology for academic purposes: a mixed-method analysis. Cogent Educ. 2025;12(1):2553835. https://doi.org/10.1080/2331186X.2025.2553835.
81. Tadeko N, Fitrasari D, Syamsu, Kamaluddin. (2024). TPACK e-learning development for increasing pedagogical competence in science's teacher. AIP Conference Proceedings, 3058(1), 40013. https://doi.org/10.1063/5.0201247
82. Tadeko N, Wilujeng I. (2024). The effect of technological pedagogical content knowledge website-based on the pedagogical competence of integrated science teachers in Banggai Indonesia. AIP Conference Proceedings, 3058(1), 40012. https://doi.org/10.1063/5.0201246
83. Townsend RB. Seeing the Past with Computers: Experiments with Augmented Reality and Computer Vision for History. Oxford University Press; 2022. https://doi.org/10.1093/jahist/jaac110.
84. Tripoulas C, Koutromanos G. The use of augmented reality in teaching history to primary and secondary-school students in formal and informal learning environments: A review of the literature. Interact Mob Communication Technol Learn. 2024;3–14. https://doi.org/10.1007/978-3-031-54327-2_1.
85. Venkatesh V, Bala H. Technology acceptance model 3 and a research agenda on interventions. Decis Sci. 2008;39(2):273–315. https://doi.org/10.1111/j.1540-5915.2008.00192.x.
86. Venkatesh V, Davis FD. A theoretical extension of the technology acceptance model: Four longitudinal field studies. Manage Sci. 2000;46(2):186–204. https://doi.org/10.1287/MNSC.46.2.186.11926.

87. Wangdi T, Dhendup S, Gyelmo T. Factors influencing teachers' intention to use technology: Role of TPACK and facilitating conditions. Int J Instruction. 2023;16(2):1017–36. https://doi.org/10.29333/iji.2023.16254a.
88. Wilujeng I, Purwasih D, Hastuti PW, Tyas RA, Susilowati S, Widowati A, Sulistyowati A, Rahimmiditya KK, Zakwandi R. Reconstruct local potential as learning resources to support science learning. KnE Social Sci. 2024;524–32. https://doi.org/10.18502/kss.v9i19.16543.
89. Wilujeng I, Tadeko N, Dwandaru WSB. Website-based technological pedagogical and content knowledge for learning preparation of science teachers. Jurnal Cakrawala Pendidikan. 2020;39(3):545–59. https://doi.org/10.21831/cp.v39i3.31228.
90. Wu Y-L, Chou W-H, Li F. (2023). The design methods of augmented reality in a historical site. Proceedings of the 2023 7th International Conference on Virtual and Augmented Reality Simulations, 52–58. https://doi.org/10.1145/3603421.3603429
91. Zaky M, Jarnawi M, Pahriadi P, Tadeko N. Penggunaan Media Augmented Reality Berbasis Kearifan Lokal Bapidok Baku bagi Guru di SMP Kecamatan Balantak dalam Upaya Memperkuat Literasi. J Hum Educ (JAHE). 2024;4(5):930–40. https://doi.org/10.31004/jh.v4i5.1614.

Figures

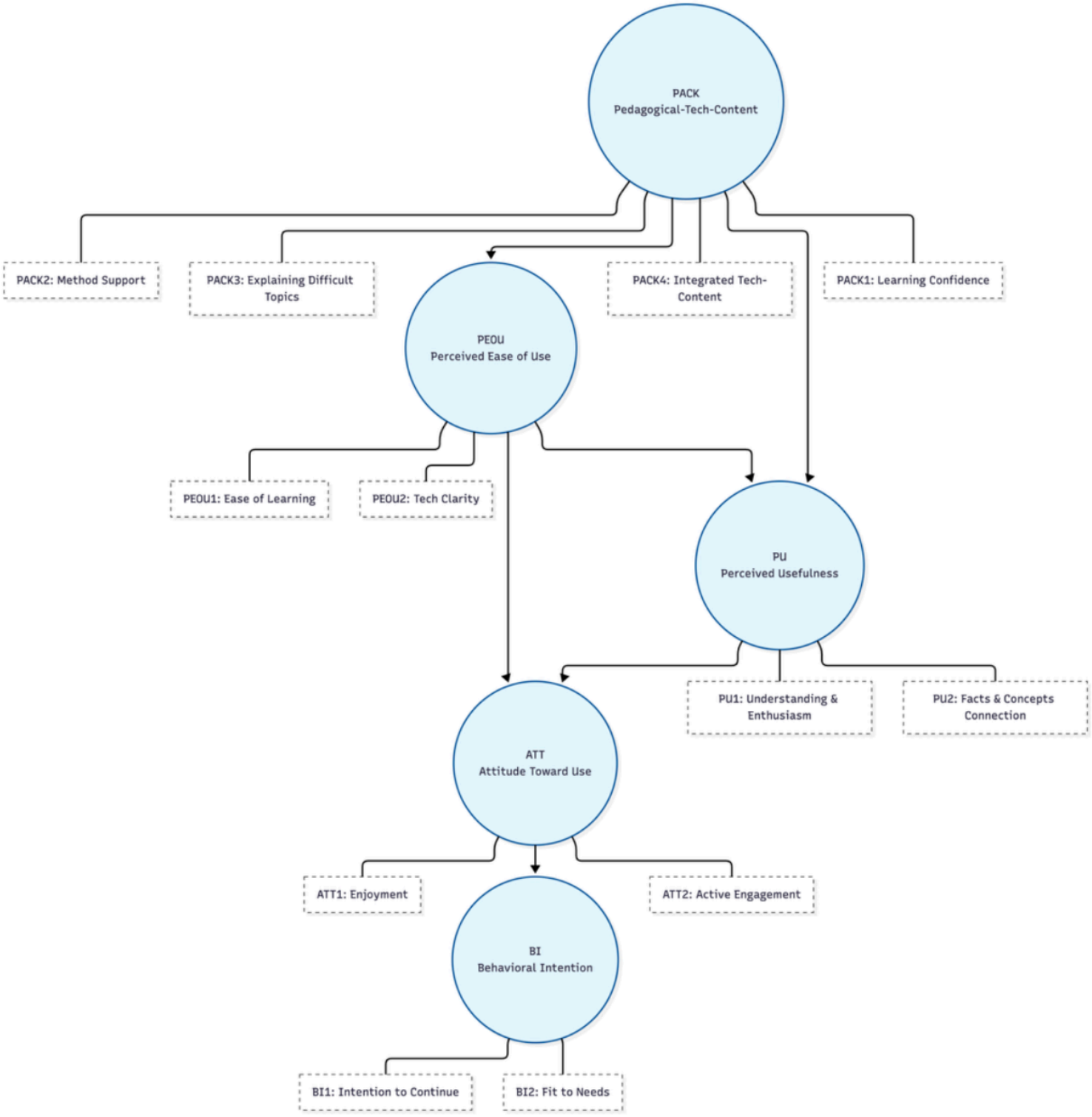


Figure 1

Integrated TAM–PACK model for students' acceptance of history learning media