User Perspectives on Project-Based Learning in 360° Virtual Reality Heritage Tours

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DOI: https://doi.org/10.47772/IJRISS.2026.101000726

Received: 01 November 2026; Accepted: 06 November 2026; Published: 17 November 2026

ABSTRACT

This study explores user perspectives on a 360-degree virtual reality (VR) heritage tour developed through a Project-Based Learning (PBL) initiative. Originating as a Final Year Project by Diploma in Tourism students at Politeknik Merlimau Melaka, Malaysia, the project tasked students with designing a VR tour of heritage sites in Bandar Hilir. To move beyond internal academic grading, the completed VR tour was exhibited at an innovation competition, facilitating external evaluation. The study primarily adopted a qualitative case study design, supplemented by a descriptive survey. To capture a holistic view, the qualitative approach involved two sets of informants: the four student creators (to evidence the PBL learning process) and four external users who experienced the VR tour at the booth (comprising two polytechnic students and two academicians). The data were analysed via Reflexive Thematic Analysis. The supplementary quantitative data (n=21), collected via convenience sampling, provided contextual insights into broader user acceptance. The analysis yielded three themes regarding student learning (Skills, Perception, Career) and four themes regarding user experience: (1) Immersive Presence; (2) Interactive Engagement; (3) Educational Value; and (4) Tourism Potential. The adequacy of the small qualitative samples was justified through the concept of information power. Triangulation of the findings suggests that the students' project work produced a VR product perceived by users as immersive and educationally valuable. The study synthesises Kolb's Experiential Learning Theory and Davis's Technology Acceptance Model into an Integrated Conceptual Framework. The study contributes a practical pedagogical model for vocational tourism education and provides a preliminary proof of concept for utilising immersive technology in heritage interpretation.

Keywords: virtual reality, heritage tourism, project-based learning, user perspectives, innovation competition, Bandar Hilir

INTRODUCTION

The integration of digital technology has transformed how tourists experience, interpret, and engage with heritage sites. For cultural heritage tourism, this digital shift presents both significant opportunities and distinct challenges. Heritage sites increasingly struggle to capture the attention of younger, digitally native audiences, who often perceive traditional interpretation methods such as static signage, printed brochures, or basic audio guides that disconnected them from media-rich daily lives. Zhang et al. (2024) highlighted that younger, higher-income, and STEM-educated visitors report significantly greater satisfaction with digital services at heritage sites, prioritising usability, quality, and enhanced experiential value. Consequently, the adoption of digital tools is not merely a technical choice but a strategy to determine which heritage sites can effectively reach and engage.

Melaka UNESCO World Heritage Site demonstrates this challenge. Bandar Hilir, the historic core of Melaka, possesses a rich tapestry of history and culture. Despite aggressive tourism promotion, the effort to make younger generations understand and value history remains an unresolved issue. The core problem is interpretive and pedagogical, ie how can heritage be presented to feel interesting, interactive, and worthy of persistent attention for young audiences?

Tourism educators play an essential role in addressing this. They must prepare students for a tourism industry where digital competence is increasingly non-negotiable. Project-Based Learning (PBL) has emerged as an effective pedagogical approach to meet this mandate, focusing on active learning through solving real-world problems (Doğantan, 2025). Through PBL, students transition from passive consumers to active creators of digital content. However, empirical accounts of PBL implementation within vocational tourism settings, particularly within Malaysian polytechnics, remain scarce.

Despite the widespread adoption of PBL, a critical gap persists in how its outcomes are evaluated. Traditionally, PBL projects are assessed solely by lecturers using academic rubrics. Consequently, there is limited understanding of how these final products perform in real-world scenarios. Specifically, there is a lack of research examining how external audiences both target users and domain experts perceive student-generated digital tools. Garnering feedback from external users is crucial because the success of a heritage interpretation tool depends on its ability to educate and engage its target demographic, not just on its academic merit.

To address this gap, this study explores external user perspectives on a PBL initiative. Final year students, Diploma in Tourism Management, Politeknik Merlimau Melaka were tasked with designing a 360-degree VR heritage tour of Bandar Hilir as their Final Year Project (FYP). To obtain authentic, real-world feedback and mitigate potential biases, the students presented their VR project at an innovation competition. There, it was experienced and evaluated by attendees, comprising external polytechnic students and academics. This external validation was essential to determine whether the project successfully addressed the engagement problem.

The research objectives were threefold: (1) to explore how external users experienced the immersive and interactive features of the student-built 360-degree VR tour; (2) to understand external user views on the educational value of the VR tour in aiding their comprehension of Bandar Hilir's heritage; and (3) to assess the perceived potential of the VR tour as a tourism marketing and engagement tool. The study is theoretically grounded in Kolb's (1984) Experiential Learning Theory (ELT), which explains the Diploma students' pedagogical process in creating the tour, and Davis's (1989) Technology Acceptance Model (TAM), which frames the external users' acceptance and evaluation of the technology.

LITERATURE REVIEW

Theoretical Underpinning: Experiential Learning and Technology Acceptance

The pedagogical context of this project is anchored in Kolb's (1984) Experiential Learning Theory (ELT), which conceptualises learning as a cyclical process encompassing four stages: concrete experience, reflective observation, abstract conceptualisation, and active experimentation. In vocational tourism education, ELT bridges theoretical instruction with professional practice. The FYP structure mirrored this cycle ie students initiated the process with a concrete experience by conducting site research and capturing 360-degree footage; they engaged in reflective observation by evaluating current heritage interpretation methods; abstract conceptualisation occurred as they synthesised historical data into a narrative storyboard; and active experimentation was realised when they produced the VR tour and tested it publicly at the innovation competition. ELT thus provides the explanatory mechanism for how students translated their learning into a tangible digital product.

In addition to the pedagogical framework, the Technology Acceptance Model (TAM) developed by Davis (1989) provides a framework for understanding the perspective of the external users. TAM posits that technology adoption is primarily influenced by *perceived usefulness* (the belief that the technology enhances an experience) and *perceived ease of use* (the belief that the technology is free of effort). Within heritage tourism, TAM has been extensively applied to immersive media. Notably, Chin et al. (2024) investigated young travellers' intentions to use VR in Sarawak, Malaysia. Based on 250 responses, they identified that information quality, media richness, and interactivity strongly influence the intention to use VR. Their findings establish that young Malaysians are highly receptive to VR when it offers rich, interactive experiences. This present study applies TAM to evaluate how the external attendees perceived the usefulness and ease of use of the VR tour..

Project-Based Learning in Tourism Education

Project-Based Learning (PBL) requires students to collaboratively solve authentic problems and design solutions. In vocational education, PBL closely simulates real professional work compared to traditional didactic lectures. Doğantan (2025) provides a recent example in tourism education, demonstrating that PBL integrated with information and communication technologies increased student satisfaction, motivation, and higher-order thinking skills such as research and problem-solving.

However, a persistent critique of PBL is the narrowness of its assessment. When projects are graded exclusively by lecturers, the evaluation of the final project is often compromised. Students might achieve high grades for products that lack actual industry relevance. In the Malaysian polytechnic context, successful PBL requires alignment between assessment, lecturer facilitation, and industry linkages (Sadrina et al., 2018). Presenting an FYP at an innovation competition serves as a form of authentic assessment. It exposes the student-made product to external scrutiny, shifting the evaluative paradigm from "Did the student pass?" to "Does this product work for the target audience?" This study leverages the innovation competition to obtain real-world validation, specifically capturing the perspectives of external users.

360-Degree Video as Heritage Interpretation

Immersive media is increasingly common in heritage interpretation. Among the available technologies, 360-degree video is particularly practical and accessible. Unlike fully synthetic Virtual Reality (VR), which requires expensive computer-generated imagery, 360-degree video captures the actual visual and auditory environment of a location. This allows users to look around and experience a profound sense of presence, or the feeling of "being there" (Argyriou et al., 2017).

Research on user responses to 360-degree media is growing. Meier et al. (2024) created a virtual tour using 360-degree photos of the Chapel of Dolores in Tenerife. Their findings indicated that viewing on a smartphone was more comfortable and induced less dizziness than using a VR headset, demonstrating that expensive hardware is not always superior. Furthermore, Ariya et al. (2025) compared VR, VR360, and mixed reality in museums. While they found no significant difference in intrinsic motivation, VR and mixed reality provided a better sense of presence than VR360. For vocational education, where budgets are constrained, 360-degree video represents a viable starting point. It is cost-effective and accessible on common devices. This study builds on this literature by focusing on how this specific medium conveys heritage narratives to external student audiences.

METHODOLOGY

Research Design and Ethics

This study primarily employed a qualitative case study design, supplemented by descriptive survey data. The case was a single PBL project (the FYP) that culminated in an external evaluation at an innovation competition. This design was chosen to obtain deep, contextualised insights into both the student learning process and the external user experience. Ethical approval for this study was obtained from the institutional research ethics committee. All participants provided informed consent prior to their involvement.

Pedagogical Design and Innovation Competition Context

The project was implemented over one academic semester. The students commenced by establishing a theoretical foundation in heritage tourism and 360-degree VR technology. They conducted situational analyses of Bandar Hilir, designed the evaluation instrument, and captured 360-degree video footage at several heritage sites.

The VR tour was structured as a cohesive narrative journey, commencing at the Melaka River near Tan Kim Seng bridge and proceeding through landmarks including the Tan Beng Swee Clock Tower, Queen Victoria Fountain, Christ Church, Stadthyus building, St. Paul's Church, the Melaka Sultanate Palace Museum, and the Dutch Landpoort (Land Gate), (which the public mistakenly known it as Porta de Santiago/A Famosa).

The VR experience lasted approximately 10 to 15 minutes. The tour was recorded using a 360-degree camera and subsequently viewed by participants using a smartphone-based VR headset (mobile VR box). Participants inserted their smartphones into the headset to view the immersive video. By utilising the smartphone's built-in gyroscope, participants could turn their heads to look around the 360-degree environment. As the narrative progressed along the heritage trail, the immersive video provided a first-person walking experience, allowing users to navigate Bandar Hilir virtually without being physically present.

The completed VR tour entered an innovation competition held at Politeknik Merlimau. During the event, attendees visited the booth, utilised headsets, and experienced the 360-degree tour. Following the experience, the students administered a supplementary descriptive survey to 21 attendees.

Separately, four other attendees who experienced the VR tour were approached for in-depth interviews. Using purposive sampling, the researchers selected two polytechnic students (representing the target demographic) and two academicians (representing domain experts). These four informants were chosen from attendees who expressed willingness to provide detailed experiential feedback, ensuring the collection of rich, qualitative data independently from the survey respondents.

Participants and Sampling

This study involved three distinct groups of participants to provide a comprehensive evaluation. First, Student Creators (n = 4): The four Diploma students who designed and produced the VR tour. They were interviewed to evidence the PBL learning process (addressing ELT). Second, External User Informants (n = 4): Four external attendees at the innovation competition, comprising two polytechnic students and two academicians. Using purposive sampling, these individuals were chosen because they demonstrated high engagement and willingness to provide detailed feedback. Though this introduces a potential positive bias (acknowledged in the Limitations), it ensured rich, experiential data. Crucially, these informants were not the creators of the project, mitigating self-reporting bias. Third, Quantitative Respondents (n = 21): Attendees at the exhibition booth who completed the supplementary descriptive survey via convenience sampling.

A common misconception in qualitative research is the necessity of achieving "data saturation", which erroneously implies a requirement for large participant numbers. Braun and Clarke (2021b) challenge this assumption within reflexive thematic analysis, arguing that saturation is conceptually incoherent because themes are interpretive constructions rather than finite entities waiting to be discovered. Instead, sample adequacy should be evaluated based on the study's purpose and the richness of the data.

This study adopted information power as the guiding principle for sample size, following Malterud et al. (2016). Information power posits that the more relevant information a sample possesses relative to the study's aim, the fewer participants are required. This study satisfied the five dimensions of information power: (1) the aim was narrow and interpretive, focusing specifically on the VR user experience; (2) the sample specificity was high, as the four informants were external attendees who had just experienced the full VR tour; (3) the use of established theory (TAM) provided conceptual direction; (4) the quality of dialogue was high, yielding rich, reflective accounts; and (5) the analytical strategy was reflexive thematic analysis, prioritising depth over breadth.

Boddy (2016) further supports this approach, arguing that the smallest acceptable sample size can be one, provided the case is information-rich. In this study, the four external participants were treated as key informants providing mutually enriching perspectives on a single, bounded VR experience. The study does not claim statistical generalisability or saturation; it claims contextual and interpretive insight.

Additionally, a supplementary survey was administered to 21 attendees at the innovation competition using convenience sampling. These were individuals who voluntarily visited the exhibition booth and agreed to participate after experiencing the VR tour. The majority were high-education level students (86%). Because this data was collected via convenience sampling, it is explicitly treated as descriptive and supplementary, serving only to provide contextual breadth to the primary qualitative findings.

Interview Protocol and Data Collection Procedure

The data collection was highly structured, utilising two distinct semi-structured interview protocols tailored to the two groups of qualitative informants.

Protocol A: External Users (n=4)

For the external users, interviews were conducted on the spot immediately after they experienced the VR tour, lasting 10 to 15 minutes. The protocol was divided into three main domains:

1. User Experience: (e.g., "Can you describe how you felt while navigating the 360-degree environment?", "Did the interface feel natural or confusing to use?")

2. Educational Element: (e.g., "To what extent did the VR tour help you understand the history of Bandar Hilir?", "How did the visual elements compare to traditional reading materials?")

3. Usefulness: (e.g., "In your opinion, how useful would this VR tour be for actual tourists visiting Melaka?", "Would you recommend this experience to a friend?")

Protocol B: Student Creators (n=4)

For the student creators, interviews were conducted post-project to capture their PBL learning journey. The protocol was divided into four main domains to align with Kolb's Experiential Learning Theory:

1. Roles and Skill Development: (e.g., "Can you briefly describe your role and involvement in this VR project?", "What new knowledge or skills did you gain from the process (technical, research, or soft skills)?")

2. Challenges and Problem-Solving: (e.g., "Can you share the biggest challenge you faced during this project and how did you overcome it?")

3. Heritage Perception Shift: (e.g., "Before starting this project, what was your perception of heritage attractions like those in Bandar Hilir?", "Did that perception change after you conducted the research and conceptualized this VR experience?")

4. Value and Career Readiness: (e.g., "What is the greatest value that a project like this brings to you as a tourism student compared to exams?", "Did the experience from this project influence your interest in a future career in digital tourism?")

In addition to the qualitative interviews, a supplementary quantitative survey was administered to 21 attendees at the innovation competition. This survey was designed by the student creators as part of their PBL deliverable, providing them with authentic experience in research instrument design. The survey was administered immediately after participants completed the VR tour at the exhibition booth.

It utilised a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) and contained items adapted from heritage satisfaction and technology acceptance studies. Specifically, the items measured in this study included: (1) "I am aware of the Heritage Trail in Bandar Hilir"; (2) "The 360-degree VR tour can enhance the visitor experience on the Heritage Trail"; (3) "The VR tour helps me understand the history of heritage sites better"; and (4) "The use of VR technology can attract more visitors to the Heritage Trail".

The survey was collected using a convenience sampling method, targeting attendees who voluntarily agreed to participate. It is important to reiterate that this survey was treated strictly as descriptive and supplementary data; no inferential statistics were applied, and no claims of statistical generalisability are made.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue X October 2026

Reflexive Thematic Analysis

The verbatim transcripts from the four external users were analysed using Reflexive Thematic Analysis (RTA) (Braun & Clarke, 2006; 2021a). To ensure systematic data management and analytical rigour, the transcripts were imported into ATLAS.ti. The software facilitated the systematic coding process (semantic and latent), categorisation, and the mapping of patterns across the user dataset.

For the external users, the analysis followed a systematic six-phase process, yielding 37 initial codes (21 semantic, 16 latent). For the student creators, the analysis focused on extracting themes related to the PBL experience to validate the ELT framework without overly cluttering the primary focus on user evaluation.

Analytical Procedure and Thematic Development

To ensure transparency, the analytical process is presented below, detailing how the raw data was systematically transformed into final themes through the six phases of RTA.

Phase 1: Familiarisation with the Data

The first author repeatedly read the transcripts to gain a holistic understanding of the users' experiences. Initial notes were made regarding repeated words, emotional tones, and surprising elements.

Table 1. Phase 1: Familiarisation Notes

Informant	**Repeated Words**	**Emotional Tone**	**Key Tensions**
P1 (Uni Student)	"Walking", "See", "Alive"	Excitement, wonder	Static reading vs. Visual experience
P2 (Uni Student)	"Interactive", "Look around", "Fun"	Engaged, curious	Passive watching vs. Active exploring
P3 (Academic)	"Beautiful", "Identity", "History"	Appreciative, reflective	Tourism promotion vs. Educational depth
P4 (Academic)	"Easy", "Promote", "Useful"	Practical, analytical	Entertainment vs. Practical utility

Table 1 demonstrates the initial familiarisation phase. By noting the different emotional tones from the students' excitement (P1, P2) to the academics' analytical appreciation (P3, P4), the researcher was sensitised to the dual nature of the VR tour as both an engaging experience and a practical educational/marketing tool.

Phase 2 & 3: Generating Initial Codes and Searching for Themes

The data were coded systematically at both semantic (surface) and latent (underlying) levels. A total of 37 initial codes were generated (21 semantic codes and 16 latent codes). These codes were then clustered into four candidate themes based on shared meanings.

Table 2. Phase 2 & 3: Initial Codes and Themes

Theme	Semantic Codes (21)	Latent Codes (16)
T1: Immersive Presence	360-degree navigation, visual immersion, spatial orientation, feeling of walking, environmental depth, visual richness.	Spatial presence, sense of "being there", overcoming physical distance, sensory engagement.

T2: Interactive Engagement	User interaction, self-paced learning, looking around, head movement, exploration.	Active exploration, user control, intrinsic motivation, freedom of choice.
T3: Educational Value	Multimodal learning, visual history, narrative storytelling, understanding facts, memory retention.	Cognitive retention, bridging past and present, historical empathy, tangible learning.
T4: Tourism Potential	Marketing application, pre-visit orientation, tourist information, recommendation, attraction.	Perceived usefulness, adoption intention, commercial viability, destination marketing.

Table 2 shows the progression from coding to theme generation. The semantic codes reflect what the users explicitly said (e.g., "360-degree navigation"), while the latent codes capture the underlying meaning (e.g., "spatial presence"). This clustering process revealed four distinct areas of user experience.

Phase 4: Reviewing Themes

The candidate themes were systematically tested for internal homogeneity (do the codes within a theme fit together?) and external heterogeneity (are the themes sufficiently distinct from one another?).

Table 3. Phase 4: Reviewing Themes

Theme	Internal Fit (Homogeneity)	External Distinct (Heterogeneity)	Decision
T1: Immersive Presence	YES. All codes relate to the feeling of "being there".	Distinct from interactivity (which is about doing, not feeling).	Keep
T2: Interactive Engagement	YES. Codes focus on user control and exploration.	Distinct from immersion (which is about spatial feeling).	Keep
T3: Educational Value	YES. Codes cluster around learning and retention.	Distinct from tourism potential (which is about marketing).	Keep
T4: Tourism Potential	YES. Codes relate to practical industry use.	Distinct from education (which is about learning, not marketing).	Keep

Table 3 acts as a quality control mechanism. For instance, the researcher ensured that "Immersive Presence" (a psychological state) was not mixed with "Interactive Engagement" (a physical action). All four themes passed the review, confirming their conceptual clarity.

Phase 5: Defining and Naming Themes

Each theme was assigned a clear definition, accompanied by a representative quote to anchor the interpretation in the participants' voices.

Table 4. Phase 5: Defining and Naming Themes

Theme	Definition	Representative Quote
T1: Immersive Presence	The psychological sense of "being physically present" in the virtual heritage site, achieved through 360-degree visual and spatial cues.	*"I felt like I was actually walking in Bandar Hilir... I had to turn my head to see the clock tower." (P1)*

T2: Interactive Engagement	The active cognitive and physical participation of the user in controlling their viewing experience and exploring the virtual space.	*"I could look up at the sky, look down at the ground... it was very interactive. You can explore at your own pace." (P2)*
T3: Educational Value	The perceived effectiveness of the VR tour in enhancing the user's understanding, memory, and appreciation of historical facts through multimodal learning.	*"I understand the history better because I can see the buildings while hearing the story. VR makes history more alive." (P3)*
T4: Tourism Potential	The user's recognition of the VR artefact's practical utility as a marketing, orientation, or engagement tool for the tourism industry.	*"This would be great to promote Melaka to tourists before they arrive. I would definitely use this at a tourist information centre." (P4)*

Table 4 finalises the analytical narrative. The definitions clearly delineate the boundaries of each theme, providing a robust foundation for the subsequent findings.

FINDINGS

1.1 The Student Creators' PBL Experience (ELT Perspective)

To evidence the learning process, interviews with the four student creators were analysed, yielding three main themes.

4.1.1 Digital and Research Competencies: Students acquired technical skills in 360-degree videography and editing (R2, R3). They also developed research skills. R4 explained: "finding accurate historical information... to ensure the content was authentic."

4.1.2 Transformative Heritage Perception: Initially, some viewed heritage as "less interesting and only for tourists" (R2). The process fostered deeper appreciation. R4 noted: "My perception changed. I realized that every building... is a cultural and historical identity."

4.1.3 Career Readiness in Digital Tourism: The project influenced future aspirations. R4 stated: "It opened my eyes to the great potential of digital tourism," while R2 emphasised it provided "real experience."

1.2 External User Experience (TAM Perspective)

The thematic analysis of the four external users yielded four core themes.

1.2.1 Theme 1: Immersive Presence

P1 (a polytechnic student) articulated: “I felt like I was actually walking in Bandar Hilir... I had to turn my head to see the clock tower.” This was echoed by P3 (an academician): “The 360-degree view made me feel like I was there, not just looking at a flat picture.” The 360-degree format successfully transported users to the historical site, supporting Argyriou et al. (2017).

1.2.2 Theme 2: Interactive Engagement

P2 (a polytechnic student) observed: “I could look up at the sky, look down at the ground... it was very interactive.” P4 (an academician) contrasted this with traditional media: “It’s not boring like reading a book. You can explore at your own pace.” The ability to control the viewing angle sustained interest, aligning with Chin et al. (2024).

1.2.3 Theme 3: Educational Value

P3 (an academician) explained: "I understand the history better because I can see the buildings while hearing the story." P2 (a polytechnic student) emphasised: "VR makes history more alive... it helps the younger generation understand it." The integration of visual immersion with narrative storytelling rendered historical facts more memorable.

1.2.4 Theme 4: Tourism Potential

P4 (an academician) suggested: "This would be great to promote Melaka to tourists before they arrive." P3 (an academician) concurred: "I would definitely use this if I visited a tourist information centre." Participants viewed the VR tour as a viable marketing asset, supporting TAM's construct of perceived usefulness (Davis, 1989).

Supplementary Descriptive Survey

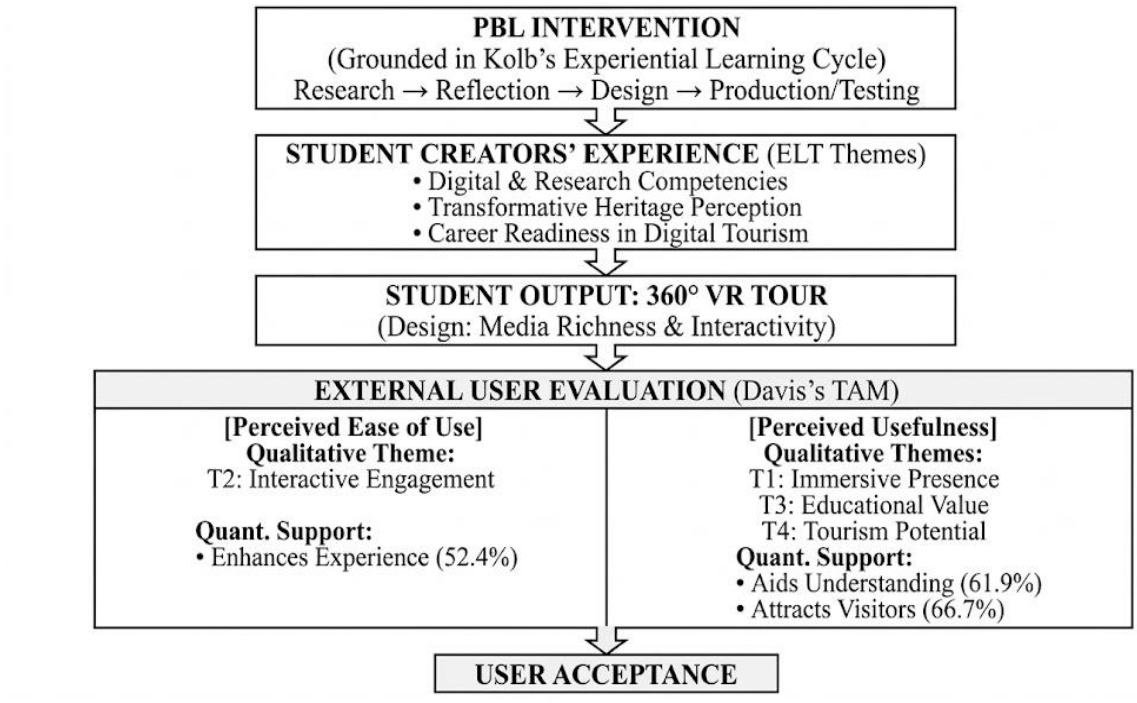
The supplementary descriptive survey (n=21) provides contextual data. Awareness of the heritage trail was moderate (52.4% aware). Receptiveness to the VR tour was moderately positive: 52.4% believed it could enhance the visitor experience, 61.9% felt it would aid understanding, and 66.7% agreed it could attract more visitors.

It is crucial to note that this survey was treated strictly as descriptive and not inferential. It served to provide a broad overview of user acceptance, which was subsequently integrated with the primary qualitative findings.

Triangulation and Conceptual Framework

Integrating the two qualitative strands reveals a coherent narrative. The Student Creators' experience validates Kolb's ELT, demonstrating how the PBL process fostered skills and career readiness. This process produced a high-quality VR Product. When External Users evaluated this product, their responses aligned with TAM constructs, confirming its usefulness. This study synthesises ELT and TAM into an Integrated Conceptual Framework (Figure 1).

Figure 1. The Integrated ELT-TAM Conceptual Framework for PBL-Driven VR Heritage Experience



(Source: Author's own work)

The framework presented in Figure 1 illustrating the complete educational cycle from pedagogical intervention to user acceptance. The explanation is divided into four interconnected stages:

1. The Pedagogical Stage (PBL Intervention & ELT)

The framework begins with the PBL Intervention, which is grounded in Kolb's Experiential Learning Cycle. The students engaged in a four-stage process: Research (concrete experience), Reflection (reflective observation), Design (abstract conceptualisation), and Production/Testing (active experimentation). This rigorous pedagogical process resulted in the Student Creators' Experience, captured through three themes: the development of Digital and Research Competencies, a Transformative Heritage Perception, and Career Readiness in Digital Tourism. This stage validates the ELT, suggesting that the PBL process equipped the students with industry-relevant skills.

2. The Mediating Product (Student Output)

The skills acquired by the student creators (Stage 1) directly informed the quality of the Student Output: the 360-degree VR Heritage Tour. The framework highlights two critical design elements of this product: Media Richness (the visual quality of the 360-degree environment) and Interactivity (the ability to navigate the space). This output acts as the bridge between the students' learning process and the external users' evaluation.

3. External User Evaluation (Davis's TAM)

When external users experienced the VR output, their evaluation was captured through the lens of the Technology Acceptance Model (TAM), which is divided into two core constructs ie One, Perceived Ease of Use: This construct is mapped to T2 (Interactive Engagement). The rationale is that users perceived the VR tour as easy to navigate because the interactive control (turning their heads to explore) required low cognitive effort. The interface felt natural to them, and Two, Perceived Usefulness: This construct is mapped to three themes which are T1 (Immersive Presence): Users found the tool useful because the 360-degree format allowed them to genuinely "feel" like they were walking in Bandar Hilir, adding experiential value, T3 (Educational Value): Users found the tool useful for learning, as the visual immersion helped them understand and retain historical facts better than static media. Finally, the T4 (Tourism Potential): Users recognised the tool's practical utility as a marketing or pre-visit orientation asset.

4. Triangulation and User Acceptance

The qualitative themes (T1-T4) are further supported by the supplementary quantitative data. Descriptive statistics showed that 52.4% agreed the VR tour enhances the visitor experience (supporting T1), 61.9% agreed it aids understanding (supporting T3), and 66.7% agreed it attracts visitors (supporting T4). The convergence of the qualitative depth and quantitative breadth culminates in the final stage: User Acceptance.

This framework contributes a theoretical synthesis, demonstrating that a strong PBL pedagogical process (ELT) is the foundation for creating a digital product that successfully meets the criteria of technology acceptance (TAM) from the end-user's perspective.

DISCUSSION

Implications for Pedagogy

This study underscores the value of extending PBL projects beyond the classroom. The findings suggest that when students are aware their FYP will be externally evaluated, their investment intensifies. The student creators' narratives evidence the development of technical, research, and career readiness competencies (validating ELT). Subjecting the product to external testing indicated that the students' learning transcended theoretical boundaries. The finding on Educational Value, supported by 61.9% agreement in the survey, indicates the students successfully translated complex historical narratives into an engaging format.

Implications for Industry and Heritage Management

For tourism stakeholders in Melaka, this study offers a preliminary proof of concept. External users acknowledged the Tourism Potential of the VR tour, with 66.7% of survey respondents agreeing it could attract visitors. This suggests that 360-degree VR can serve as an effective pre-visit orientation tool. However, the tour's

success was predicated on rigorous historical research and narrative design. This underscores the need for industry-education partnerships to ensure immersive content is both engaging and historically accurate.

The Tangible Value of Vocational Education

A significant takeaway is the demonstration of the tangible value generated by vocational education. Traditionally, vocational students are positioned as consumers of knowledge. Within this PBL framework, they evolved into digital heritage producers. The positive feedback from external users reflects the substantial effort and technical expertise of the Diploma students. By evaluating the final product through the lens of the end-user, the study highlights how vocational education can bridge the gap between academic learning and industry relevance.

Limitations and Future Research

This study acknowledges several limitations. First, the qualitative sample is small (n=4 for users, n=4 for creators). Even though this is justified through information power (Malterud et al., 2016) and Boddy (2016), the findings remain contextually bound. Second, selecting users who demonstrated "high engagement" introduces a positive bias. Third, the absence of negative or critical user comments restricts the scope of the evaluation, and usability issues (e.g., motion sickness) were not systematically probed. Fourth, the quantitative sample (n=21) is small, convenience-based, and lacks inferential testing. Fifth, the evaluation occurred at a competition booth, an artificial setting that may have influenced the sense of presence. Finally, the first author was the students' supervisor (requiring reflexive practice), the risk of bias was mitigated by the external users being independent of the project creators.

Future research should address these limitations by employing a larger, more diverse sample, including users with neutral or negative views, and systematically probing usability issues. Future studies could also employ inferential statistics to test the TAM model quantitatively and evaluate the VR tour at naturalistic heritage sites to enhance ecological validity.

CONCLUSION

This study set out to explore user perspectives on a student-built 360-degree VR heritage tour, while also documenting the student creators' learning experience. Utilising a qualitative case study approach supplemented by descriptive data, the reflexive thematic analysis produced three themes regarding student learning and four themes regarding user experience (Immersive Presence, Interactive Engagement, Educational Value, and Tourism Potential).

By integrating these findings through Kolb’s (1984) ELT and Davis’s (1989) TAM, the study produced an Integrated Conceptual Framework illustrating how PBL outputs can be externally evaluated. The study makes three contributions. First, it provides a pedagogical model that utilises external evaluation to validate PBL outcomes. Second, it offers a preliminary proof of concept for 360-degree VR as a heritage interpretation medium. Third, it provides a methodological example of using information power and Reflexive Thematic Analysis in small-sample research.

If vocational tourism education aims to produce job-ready graduates, it must transcend traditional classroom boundaries. This study offers a replicable model for transforming Final Year Projects into industry-relevant innovations, evaluated not merely by lecturers, but by the very audiences they are designed to engage.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to the students who designed and produced the 360-degree VR heritage tour as part of their final-year project in the Diploma in Tourism Management programme at Politeknik Merlimau Melaka namely Amir Aisar Aminudin, Syed Syazwan Naqib Syed Khairul Nizar, Sritharan Nair Balakrishnan, and Muhammad Syafiq Shaiful Azwan. The authors also acknowledge the

institutional support provided by Politeknik Merlimau Melaka and the cooperation of the participants who took part in the innovation competition and survey.

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