

An Exploratory Study of Technology-Enhanced Visual Arts Education for Batik Cultural Heritage Sustainability

Norzuraina binti Mohd Nor¹, Intan Kasumarlina binti Khalid², Wong Yoke Seng³, Nurazry bin Basiron⁴, Fareez Vincent Amos@Mohd Fadly⁵, Lee Hoi Yeh^{6*}

Universiti Pendidikan Sultan Idris

*Corresponding Author

DOI: <https://doi.org/10.47772/IJRISS.2026.100600443>

Received: 01 June 2026; Accepted: 06 June 2026; Published: 26 June 2026

ABSTRACT

The sustainability of cultural heritage has gained increasing significance in education, particularly as digital technologies and global cultures rapidly evolve. Batik, a vital component of Malaysian heritage, faces challenges in maintaining its relevance among younger generations who are more engaged with digital and global visual cultures. This study investigates the potential of technology-enhanced Visual Arts Education to sustain batik heritage among Malaysian secondary school students. Guided by the Technological Pedagogical Content Knowledge (TPACK) framework, the research surveyed 25 Form Four students from three secondary schools in Kuala Lumpur. Participants completed a 25-item questionnaire assessing their awareness of batik heritage, participation in batik-related activities, and perceptions of technology-enhanced learning. While the study examines heritage awareness strategies among school students in Kedah, Malaysia, it does not report specific findings regarding students' awareness or engagement with batik heritage (Shamsuddin et al., 2022, pp. 1-12). Receptions of digital technology use in Visual Arts Education ($M = 3.98$, $SD = 0.72$). These findings suggest that technology-enhanced learning may foster greater cultural awareness, student engagement, and knowledge sharing among youth. This study contributes to ongoing discourse on heritage education, digital pedagogy, and cultural sustainability by emphasising the importance of integrating technology, pedagogy, and cultural content to ensure the continued relevance of batik heritage in the digital era.

Keywords: Batik cultural heritage; Visual Arts Education; technology-enhanced learning; cultural sustainability; TPACK; heritage education; secondary school students; digital technology.

INTRODUCTION

Cultural heritage plays a critical role in shaping a society's identity, history, and collective memory. It facilitates the transmission of knowledge, values, traditions, and practices across generations, thereby sustaining cultural identity (Logan, 2020; Zhang & Kaya, 2023). In Southeast Asia, batik represents a distinctive traditional textile art that embodies the values and narratives of local communities. Within Malaysia, batik is recognised not only as a traditional art form but also as an integral aspect of national heritage and the creative industry (Razali et al., 2021; Wang, 2019). However, globalisation, evolving fashion trends, and the influence of popular culture have increasingly challenged the relevance of traditional practices such as batik, particularly among younger generations (Logan, 2020; Kasemsarn & Nickpour, 2025). Research indicates that youth are increasingly exposed to global visual cultures and digital lifestyles, leading to diminished interest in traditional heritage and local arts (Shan, 2025; Zhang & Kaya, 2023). The challenge of sustaining cultural heritage among youth has become increasingly prominent in contemporary educational discourse. As future custodians of cultural knowledge, young people are essential to ensuring the continuity and relevance of traditional cultural practices in modern society. However, conventional approaches to cultural transmission often fail to engage digitally oriented generations whose learning preferences are shaped by technology (Kasemsarn & Nickpour, 2025; Madgin et al., 2016). Consequently, experts and policymakers advocate for innovative pedagogical methods that connect traditional cultural knowledge with youth's lived experiences and foster authentic engagement with

cultural heritage (UNESCO, 2023; Zhang & Kaya, 2023). Previous research demonstrates that heritage-based education enhances students' cultural awareness, strengthens cultural identity, and promotes active participation in traditional artistic practices (Choi & Kim, 2022; Smith & Campbell, 2023). Additionally, art education is recognised as a vital mechanism for safeguarding intangible cultural heritage by facilitating cultural transmission and encouraging students to appreciate the relevance of traditional arts in contemporary contexts (Wang, 2019; Xingyun & Widiyanah, 2026). Therefore, integrating cultural heritage into Visual Arts Education is increasingly regarded as a key strategy for promoting cultural sustainability and reinforcing students' connections to local traditions. essential strategy for promoting cultural sustainability and strengthening students' connections with local traditions.

Simultaneously, digital technology is transforming educational practices across diverse contexts. Technology-enhanced learning provides educators with expanded opportunities to design interactive, creative, and student-centred lessons that address the demands of contemporary education (Redecker, 2021; Timotheou et al., 2022). Tools such as multimedia platforms, digital design applications, virtual exhibitions, augmented reality, and interactive visuals have been shown to enhance student engagement, creativity, and learning outcomes in arts education (Anwar et al., 2023; Rizvic et al., 2020). Research further indicates that technology facilitates deeper learning by enabling students to interact with cultural content in novel and engaging ways, thereby increasing motivation and retention (McCarthy et al., 2023; OECD, 2025).

Digital technology is now seen as an important tool for preserving cultural heritage worldwide. UNESCO (2023) points out that digital technologies offer new ways to document, protect, share, and revive cultural heritage for future generations. Recent research also shows that digital platforms and social media can help young people get more involved with cultural heritage by making it easier for them to participate and express themselves. Digital technology is increasingly recognised as a vital instrument for preserving cultural heritage globally. UNESCO (2023) highlights that digital technologies provide innovative means to document, protect, disseminate, and revitalise cultural heritage for future generations. Recent studies demonstrate that digital platforms and social media facilitate greater youth engagement with cultural heritage by enabling participation, self-expression, and interactive learning (Kasemsarn & Nickpour, 2025; Shan, 2025). In heritage education, technology allows students to explore cultural narratives, symbols, and traditions in ways that align with their interests and lifestyles (Huang, 2024; Rizvic et al., 2020). Consequently, digital technology is regarded not only as an instructional tool but also as a critical mechanism for supporting cultural sustainability and transmitting heritage in the digital era. focuses on batik as a product, digital technology, or heritage preservation separately (Razali et al., 2021; Wang, 2019). There is still little evidence on how technology-enhanced Visual Arts Education can help keep batik heritage alive among secondary school students, especially in Malaysia. This shows a need for more research on how digital technologies can improve cultural awareness, student engagement, and heritage sustainability in Visual Arts Education.pecifically, the study aims to: (1) examine students' awareness and perceptions of batik as a cultural heritage asset; (2) investigate students' engagement with batik-related learning experiences; and (3) explore the potential of digital technology as a pedagogical tool for strengthening cultural heritage sustainability among youth. The findings are expected to contribute to the growing discourse on heritage-based education, digital pedagogy, cultural sustainability, and technology-enhanced Visual Arts Education within contemporary secondary school contexts.

Background of the Study

The sustainability of cultural heritage is increasingly influenced by educational institutions' ability to adapt heritage transmission practices to contemporary learning environments. While batik continues to be recognised as an important element of Malaysia's cultural identity, its presence within formal educational settings remains largely confined to introductory exposure rather than sustained engagement and critical appreciation. Previous studies have indicated that students often possess basic knowledge of batik motifs and techniques but demonstrate limited understanding of the cultural meanings, historical narratives, and symbolic values embedded within batik traditions (Akhir et al., 2015; Abdullah et al., 2018). This situation suggests that existing pedagogical approaches may be insufficient in fostering deeper cultural understanding and long-term appreciation of batik heritage among younger generations.

In Malaysian secondary schools, Visual Arts Education is one of the primary platforms through which students encounter local artistic traditions. However, contemporary educational practices face increasing challenges in maintaining students' interest in traditional cultural content amid the growing dominance of digital media and global visual culture. Studies in arts education have reported that students tend to engage more actively with learning experiences that incorporate interactive, technology-mediated, and visually stimulating content compared to conventional instructional approaches (Timotheou et al., 2022; McCarthy et al., 2023). Consequently, educators are increasingly required to redesign learning experiences that not only preserve cultural authenticity but also align with the learning preferences of digitally connected generations.

The integration of technology within Visual Arts Education has emerged as a promising strategy for addressing these challenges. Advances in digital technologies have enabled new forms of artistic exploration through graphic design software, virtual galleries, augmented reality applications, digital storytelling, and multimedia learning platforms. Such technologies offer students opportunities to engage with cultural artefacts beyond the limitations of traditional classroom instruction (Redecker, 2021; Rizvic et al., 2020). In heritage education contexts, digital technologies have been found to support experiential learning, enhance cultural interpretation, and facilitate wider access to cultural knowledge, particularly among younger audiences who are highly familiar with digital environments (Huang, 2024; Kasemsarn & Nickpour, 2025).

Despite the growing adoption of educational technologies in schools, their application within the teaching of batik and traditional visual arts remains relatively underexplored. Existing studies concerning batik have predominantly focused on design development, cultural identity, tourism, creative industries, and preservation efforts within artisan communities (Razali et al., 2021; Wang, 2019). Comparatively fewer studies have investigated how digital technologies can be systematically integrated into Visual Arts Education to strengthen students' awareness, appreciation, and engagement with batik as a living cultural heritage. Furthermore, research examining the relationship between technology-enhanced learning environments and cultural heritage sustainability within secondary school settings remains limited, particularly in the Malaysian context.

From a theoretical perspective, the Technological Pedagogical Content Knowledge (TPACK) framework offers a valuable lens for understanding how technology, pedagogy, and cultural content can be integrated effectively within Visual Arts Education (Mishra & Koehler, 2006; Koehler et al., 2019). The framework emphasises that meaningful technology integration requires more than technical competence; it also necessitates aligning digital tools with appropriate pedagogical strategies and subject content. In the context of batik education, this suggests that digital technologies should serve not merely as presentation tools but as mechanisms that facilitate cultural exploration, creative expression, and appreciation of heritage.

Although international scholarship has increasingly highlighted the importance of digital heritage education, a significant research gap remains regarding how technology-enhanced Visual Arts Education can contribute to the sustainability of batik cultural heritage among Malaysian secondary school students. There is limited empirical evidence concerning students' perceptions of batik, their level of engagement with batik-related learning experiences, and the potential of digital technologies to strengthen cultural sustainability through formal education. Addressing this gap is essential for informing future pedagogical practices, curriculum development, and heritage education initiatives that seek to balance cultural preservation with educational innovation in the digital era.

Accordingly, this study investigates the role of technology-enhanced Visual Arts Education in promoting the sustainability of batik cultural heritage among Malaysian secondary school students. Specifically, the study examines students' awareness and perceptions of batik as a cultural heritage asset and explores how digital technologies can support more meaningful engagement with batik within contemporary educational settings.

METHODOLOGY

Research Design

This study employed a quantitative research approach, using a descriptive survey design, to examine secondary

school students' awareness, perceptions, and engagement with batik cultural heritage, as well as their views on the role of digital technology in supporting the sustainability of cultural heritage through Visual Arts Education. A survey design was considered appropriate because it enables researchers to gather information from a specific population and identify patterns, attitudes, and perceptions related to educational phenomena (Creswell & Creswell, 2021). The study was guided by the Technological Pedagogical Content Knowledge (TPACK) framework, which emphasises the integration of technological, pedagogical, and content knowledge in teaching and learning contexts (Mishra & Koehler, 2006; Koehler et al., 2019).

Participants and Sampling

The study examined innovative learning approaches in Visual Arts Education in secondary schools in Malaysia, focusing on insights from a review of existing academic articles rather than a direct survey of student participants (Saleh & Sabri, 2024, pp. 20-27). Technology-enhanced batik learning. A convenience sampling technique was employed due to participants' accessibility and prior exposure to visual arts learning, including topics related to Malaysian cultural heritage, such as batik (Creswell & Creswell, 2021). Form Four students were selected because they possess sufficient experience in art-related learning and are considered capable of providing informed responses regarding cultural heritage and technology-enhanced learning experiences.

Research Instrument

Data were collected using a structured questionnaire developed based on an extensive review of the literature on cultural heritage education, Visual Arts Education, technology-enhanced learning, and cultural sustainability (Choi & Kim, 2022; Smith & Campbell, 2023; Redecker, 2021). The questionnaire comprised 25 items organised into four sections. Section A collected demographic data on gender, age, and prior experience with batik-related learning activities (Maaruf & Basri, 2019, pp. 119-136). Section B measured students' awareness of batik as a cultural heritage asset, reflecting the emphasis on intangible cultural heritage found in Malaysian core subjects such as history, Bahasa Malaysia, art, and music education. Section C examined students' engagement and participation in batik-related activities and cultural promotion (Heritage education in the Primary School Standard Curriculum of Malaysia, 2017, pp. 124-131). Section D explored students' perceptions regarding the role of digital technology in supporting batik learning, cultural appreciation, and heritage sustainability. The questionnaire employed a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Prior to data collection, the instrument was reviewed by two experts in Visual Arts Education and educational technology to establish content validity. Minor revisions were made based on their recommendations to improve clarity, relevance, and alignment with the research objectives.

Data Collection Procedure

Permission to conduct the study was obtained from the respective school administrations before data collection commenced. The questionnaires were distributed to students during scheduled Visual Arts Education sessions. Participants were informed about the study's purpose and assured that their responses would remain anonymous and confidential. Participation was voluntary, and respondents were given sufficient time to complete the questionnaire independently. The completed questionnaires were collected immediately upon completion, as response rates were identified as a critical success factor in survey-based research in Malaysia (Lee et al., 2020, pp. 1-12).

Data Analysis

The collected data were analysed using descriptive statistical techniques with the assistance of Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics, such as frequency distributions, percentages, means, and standard deviations, can be used to summarise students' responses and identify patterns in their awareness, engagement, and perceptions of batik cultural heritage and the integration of digital technology (Ponijan et al., 2019, pp. 79-92). Mean score interpretation may then be applied to categorise respondents' perceptions into low, moderate, and high levels. The findings were subsequently interpreted in relation to the study's objectives and the TPACK framework to explain the potential contribution of technology-

enhanced Visual Arts Education to the sustainability of batik cultural heritage among Malaysian secondary school students.

Ethical Considerations

This study adhered to standard ethical principles in educational research. Participation was voluntary, informed consent was obtained from participants, and all collected information was treated confidentially. No personal identifiers were recorded, and the data were used solely for academic and research purposes. This study is subject to several limitations. The sample in this study comprised only 25 students from three secondary schools in Kuala Lumpur, suggesting that the findings should be viewed as exploratory and not necessarily representative of all Malaysian secondary school students. Furthermore, the use of self-reported questionnaires may introduce bias stemming from respondents' subjective perceptions and experiences (Firdaus & Din, 2025, pp. 336-345). Future research should include larger, more diverse samples from various regions of Malaysia and employ mixed-methods approaches to gain deeper insights into students' experiences with batik heritage learning.

CONCEPTUAL FRAMEWORK

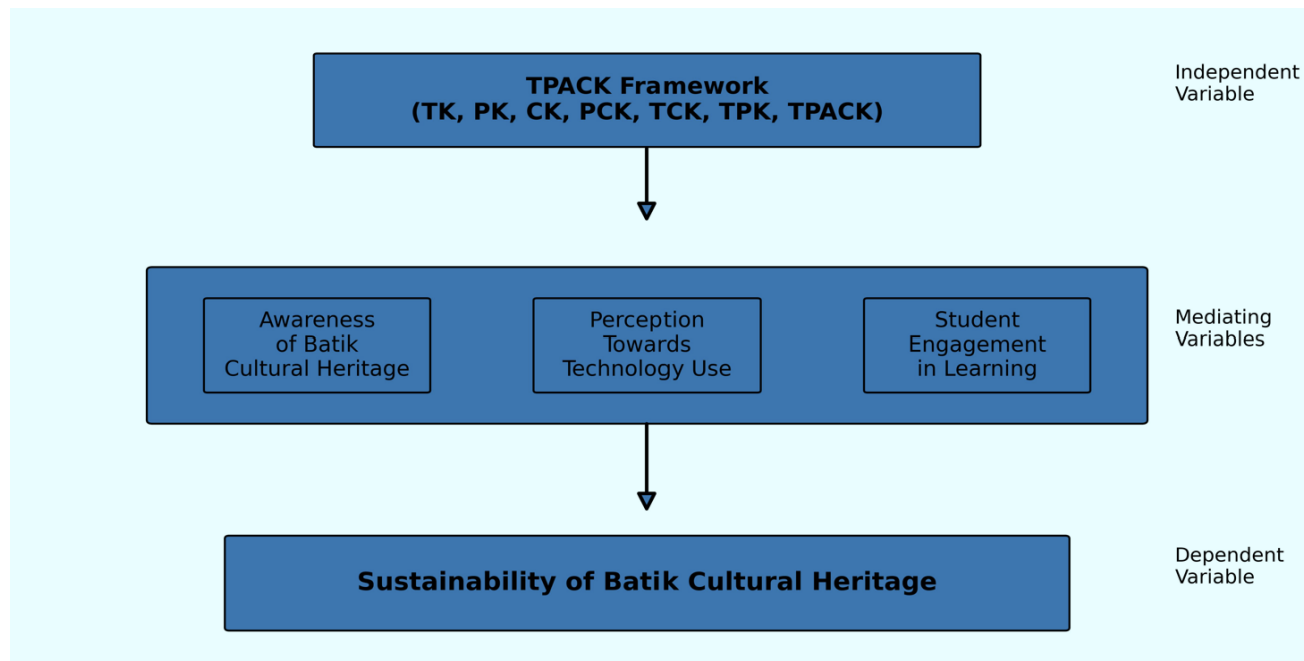
This study is grounded in the Technological Pedagogical Content Knowledge (TPACK) framework proposed by Mishra and Koehler (2006), which emphasises the effective integration of technology, pedagogy, and content knowledge in educational practice. The TPACK framework has been widely applied in technology-enhanced learning research as it provides a comprehensive understanding of how digital technologies can support meaningful learning experiences while maintaining the integrity of subject content (Koehler et al., 2019).

Within the context of this study, the content knowledge component refers to batik as a form of Malaysian cultural heritage encompassing its historical significance, symbolic meanings, aesthetic values, motifs, and traditional production techniques. Pedagogical knowledge refers to teaching approaches employed in Visual Arts Education to facilitate students' understanding and appreciation of batik heritage. Technological knowledge involves using digital tools such as graphic design applications, multimedia resources, digital storytelling platforms, virtual exhibitions, and interactive learning media to enrich students' learning experiences.

The framework further proposes that students who demonstrate higher levels of awareness, positive cultural perceptions, and active engagement are more likely to contribute to the sustainability of batik cultural heritage. Cultural sustainability in this study refers to the preservation, appreciation, transmission, and continued relevance of batik knowledge and practices among younger generations. Consistent with UNESCO's cultural sustainability agenda, education supported by digital technologies can facilitate wider access to cultural knowledge and strengthen intergenerational transmission of heritage values (UNESCO, 2023).

Therefore, the conceptual framework suggests that technology-enhanced Visual Arts Education serves as the primary mechanism through which students develop cultural awareness, positive perceptions of heritage, and active engagement, ultimately contributing to the sustainability of batik cultural heritage among Malaysian secondary school students.

Figure 1: Conceptual Framework of Study



FINDINGS AND DISCUSSION

This section presents and discusses the findings of the study concerning students' awareness, engagement, and perceptions of batik cultural heritage, as well as the role of technology-enhanced Visual Arts Education in supporting cultural heritage sustainability among Malaysian secondary school students. Guided by the Technological Pedagogical Content Knowledge (TPACK) framework, the discussion aims to examine how the integration of digital technology within Visual Arts Education influences students' understanding and appreciation of batik as a cultural heritage asset. The findings are organised into six interrelated themes: students' awareness of batik cultural heritage, students' engagement with batik-related activities, perceptions of technology-enhanced Visual Arts Education, the contribution of technology-enhanced learning towards cultural heritage sustainability, interpretation of findings through the TPACK framework, and the broader implications for Visual Arts Education and cultural heritage preservation. Through these themes, the discussion seeks to provide a comprehensive understanding of the relationship between educational technology, cultural learning experiences, and the sustainability of batik heritage among younger generations. The findings are further interpreted in relation to previous studies, contemporary heritage education discourse, and current efforts to strengthen cultural sustainability through technology-enhanced learning environments.

Students' Awareness of Batik Cultural Heritage

The findings indicated that school students in Kedah exhibited a moderate level of awareness of heritage assets, with batik recognized as an important aspect of Malaysian cultural identity, though overall understanding among students remains limited (Shamsuddin et al., 2022, pp. 1-14). largely superficial and confined to general recognition rather than deeper cultural appreciation. While most students were familiar with batik as a traditional textile art, fewer demonstrated a comprehensive understanding of its historical development, symbolic motifs, cultural narratives, and socio-cultural significance within Malaysian society. This finding reflects a common challenge in heritage education: students are often exposed to cultural artefacts as part of the curriculum but are not sufficiently engaged in exploring the cultural meanings and values embedded in them. Similar findings have been reported by Wang (2019) and Smith and Campbell (2023), who argued that heritage education frequently succeeds in introducing cultural knowledge but is less effective in fostering critical cultural understanding and long-term cultural attachment among younger generations. Consequently, awareness of cultural heritage should not be interpreted solely as knowledge acquisition but rather as a multidimensional construct involving cultural understanding, appreciation, and personal connection.

From a critical perspective, the moderate awareness level identified in this study raises important questions regarding the effectiveness of current pedagogical approaches in Visual Arts Education. Although batik is included within the curriculum, the findings suggest that its presentation may still be largely technical and product-oriented, focusing on motifs, techniques, and artistic outcomes rather than encouraging students to critically engage with the cultural, historical, and identity-related dimensions of batik heritage. Such an approach may inadvertently position batik as a classroom topic rather than a living cultural practice that continues to evolve within contemporary society. This observation supports the argument advanced by Logan (2020) that heritage sustainability requires more than preservation of artefacts; it necessitates meaningful cultural transmission that enables younger generations to understand the relevance of heritage within their own lives. Therefore, enhancing students' awareness of batik cultural heritage may require a shift towards more culturally responsive and experiential pedagogies that integrate storytelling, community engagement, cultural inquiry, and digital heritage resources. Through these approaches, students can move beyond recognising batik as a symbol of national identity towards developing a deeper appreciation of its cultural significance and its role in sustaining Malaysia's intangible cultural heritage.

Students' Engagement with Batik-related Activities

The findings indicated that students' engagement with batik-related activities was relatively low ($M = 2.41$, $SD = 0.91$), even though they demonstrated moderate awareness of batik as an important cultural heritage asset. Most respondents reported limited participation in activities such as batik exhibitions, workshops, and the production of batik-inspired artworks beyond classroom assignments (Saleh & Sabri, 2024, pp. 20-27). Promoting batik through social media and community programmes. This finding suggests that awareness does not automatically translate into active participation. While students may recognise the cultural significance of batik, their interaction with the heritage remains largely passive and confined to formal classroom experiences. Similar findings have been reported in heritage education research, suggesting that younger generations often appreciate cultural heritage conceptually but demonstrate low levels of direct engagement unless they are provided meaningful opportunities for participation and creative involvement (Zhang & Kaya, 2023; Kasemsarn & Nickpour, 2025). The findings therefore, highlight a disconnect between cultural awareness and practice, indicating that students are not yet active participants in the preservation and promotion of batik heritage.

From a critical perspective, the low engagement level may reflect broader structural and pedagogical issues within heritage education. Traditional classroom approaches frequently emphasise the acquisition of knowledge and technical skills while providing limited opportunities for authentic interaction with cultural practitioners, local communities, and contemporary creative industries associated with batik. Consequently, students may perceive batik as a historical artefact or a school subject rather than a dynamic cultural practice relevant to contemporary life. Furthermore, the influence of global digital culture has created competing interests that often position popular visual trends as more attractive and socially relevant than traditional cultural forms (Logan, 2020). This situation suggests that heritage sustainability cannot rely solely on curriculum inclusion but requires the creation of participatory learning environments that encourage students to experience, reinterpret, and communicate cultural heritage through contemporary platforms. Integrating project-based learning, community-based heritage activities, digital storytelling, social media campaigns, and collaborations with batik artisans may offer more meaningful engagement pathways. Such approaches would not only increase students' participation in batik-related activities but also strengthen their sense of ownership and responsibility towards safeguarding cultural heritage for future generations.

Perceptions of Technology-Enhanced Visual Arts Education

The findings revealed that students expressed a positive perception toward the integration of digital technology, specifically through the Wakelet Students' Ambassador Programme, for educational purposes in Visual Arts Education (Jen et al., 2023). Learning about batik and other forms of cultural heritage. Students indicated that technology-enhanced learning environments made the learning process more engaging, accessible, and relevant to their daily experiences. This finding suggests that digital technology has the potential to transform traditional heritage education into a more interactive and student-centred learning experience. Previous studies have similarly reported that technology-enhanced learning can increase students' motivation, participation, and

creativity by providing opportunities for visual exploration, collaboration, and experiential learning (Redecker, 2021; Timotheou et al., 2022). Within the context of Visual Arts Education, digital tools enable students to explore batik motifs, experiment with design concepts, and access cultural information beyond the limitations of conventional classroom instruction. Consequently, technology appears to function not only as a learning aid but also as a medium that facilitates deeper engagement with cultural content.

From a critical perspective, however, the positive perception of technology should not be interpreted as evidence that technology alone can guarantee effective heritage learning. While digital tools may increase students' interest and participation, the educational value of technology depends largely on how it is integrated into pedagogical practice. The findings highlight the importance of moving beyond technology-centred approaches towards pedagogically meaningful technology integration. Without appropriate instructional design, digital technologies risk becoming tools for superficial engagement that prioritise visual attractiveness over cultural understanding. This concern aligns with arguments advanced by Mishra and Koehler (2006), who emphasised that effective educational technology integration requires a balanced relationship among technological, pedagogical, and content knowledge. In the context of batik education, technology should serve as a bridge connecting students to the historical, cultural, and symbolic dimensions of batik rather than merely providing digital representations of traditional art forms. Therefore, the challenge for educators is not simply to incorporate technology into Visual Arts Education but to design culturally meaningful learning experiences that encourage critical reflection, creativity, and appreciation of cultural heritage. Such an approach would ensure that technology contributes to both educational innovation and the long-term sustainability of batik heritage among younger generations.

Technology-Enhanced Learning and Cultural Heritage Sustainability

The findings suggest that technology-enhanced learning possesses considerable potential to support the sustainability of batik cultural heritage among younger generations. Students generally perceived digital technologies as effective tools for accessing information, exploring batik designs, and engaging with cultural content in ways that better align with their everyday experiences. The high level of acceptance towards digital learning observed in this study indicates that technology can function as a bridge between traditional cultural knowledge and contemporary youth culture. Through digital platforms, students can access a wider range of cultural resources, explore the historical and symbolic meanings of batik motifs, and participate in creative activities that extend beyond the physical classroom. These findings support UNESCO's (2023) assertion that digital technologies play a crucial role in safeguarding cultural heritage by facilitating documentation, dissemination, accessibility, and intergenerational knowledge transmission. Similarly, recent studies have shown that digital heritage initiatives can enhance cultural participation among young people by transforming heritage learning into an interactive and immersive experience (Rizvic et al., 2020; Huang, 2024). Therefore, technology-enhanced learning can be viewed as an important mechanism for strengthening cultural sustainability through education.

Nevertheless, the findings also highlight that the sustainability of cultural heritage cannot be achieved solely through technology. While digital tools may increase accessibility and engagement, there is a risk that cultural heritage becomes reduced to visual content or digital artefacts without fostering meaningful cultural understanding. Heritage sustainability involves more than the preservation of images, motifs, or historical information; it requires the continuous transmission of cultural values, identities, practices, and collective memories across generations (Logan, 2020). Consequently, the effectiveness of technology-enhanced learning depends on its capacity to encourage critical reflection, cultural interpretation, and authentic engagement with heritage communities. In the context of batik education, digital technologies should be employed not merely to digitise traditional content but to create opportunities for students to investigate the stories, philosophies, and cultural significance underlying batik traditions. This finding suggests that sustainable heritage education requires a balanced integration of technology, cultural content, and experiential learning. By positioning students as active creators, interpreters, and advocates of cultural heritage rather than passive consumers of information, technology-enhanced Visual Arts Education can contribute meaningfully to the long-term preservation, appreciation, and continuity of batik cultural heritage within contemporary society.

Discussion within the TPACK Framework

The findings of this study can be meaningfully interpreted through the Technological Pedagogical Content Knowledge (TPACK) framework, which emphasises the dynamic integration of technological, pedagogical, and content knowledge to create effective learning experiences (Mishra & Koehler, 2006; Koehler et al., 2019). The results indicate that students demonstrated moderate awareness of batik cultural heritage and relatively low engagement in batik-related activities, yet expressed highly positive perceptions towards the use of digital technology in Visual Arts Education. This pattern suggests that integrating technology holds significant potential for enhancing heritage education within pedagogical practices, as highlighted by the call for an Artificial Intelligence teaching model to improve creativity in Visual Arts Education (Zuhairi et al., 2023, pp. 1-10). From the perspective of TPACK, technology alone is insufficient to enhance learning outcomes; rather, its effectiveness depends on its alignment with appropriate teaching strategies and meaningful cultural content. In this study, batik serves as the content knowledge component, while Visual Arts Education provides the pedagogical framework through which cultural knowledge is delivered. The positive response towards technology-enhanced learning indicates that digital tools can support students' understanding of batik by making cultural content more accessible, interactive, and relevant to contemporary learning preferences.

More importantly, the findings demonstrate that the relationship between technology and cultural heritage sustainability is mediated by pedagogical practice. The relatively low level of engagement with batik-related activities suggests that including batik in the curriculum may not be sufficient to foster active cultural participation. Instead, meaningful engagement emerges when technology is employed as a pedagogical tool that encourages exploration, creativity, collaboration, and cultural interpretation. This observation aligns with the central premise of the TPACK framework, which holds that effective technology integration occurs when educators combine technological, pedagogical, and content knowledge in a coherent manner. Within batik education, this may involve digital storytelling, virtual exhibitions, multimedia resources, digital design software, or social media projects that enable students to reinterpret cultural heritage through contemporary forms of expression. Such approaches move beyond the traditional transmission of information and position students as active participants in the construction of cultural knowledge.

From a broader theoretical perspective, the findings extend the TPACK framework beyond its conventional focus on technology integration and learning effectiveness. The results suggest that TPACK can also serve as a valuable framework for understanding how educational technologies contribute to cultural sustainability and the transmission of heritage. While previous studies have primarily applied TPACK to improve academic achievement, digital literacy, and instructional effectiveness (Koehler et al., 2019; Mishra & Koehler, 2006), this study highlights its relevance in supporting the preservation and revitalisation of intangible cultural heritage. The integration of technology-enhanced pedagogies in Visual Arts Education enables students not only to acquire knowledge of batik but also to develop cultural awareness, appreciation, and a sense of responsibility towards heritage preservation. Consequently, the findings suggest that TPACK should be viewed as a framework that facilitates both educational innovation and cultural continuity, particularly in contexts where traditional heritage knowledge must be communicated to digitally oriented generations.

Furthermore, the findings indicate that technology-enhanced Visual Arts Education can function as a contemporary platform for cultural transmission when supported by effective pedagogical design. Consistent with UNESCO's vision of digital heritage education, integrating technology into cultural learning environments can expand access to cultural resources while encouraging meaningful interaction with heritage content (UNESCO, 2023). However, the study also highlights the need for educators to maintain a balance between technological innovation and cultural authenticity. Excessive emphasis on technological tools without sufficient attention to cultural meaning may result in superficial learning experiences that prioritise visual engagement over cultural understanding. Therefore, the successful implementation of TPACK within batik education requires educators to ensure that technology serves as a medium for cultural exploration rather than an end in itself. In this way, the TPACK framework provides a comprehensive theoretical foundation for understanding how technology-enhanced Visual Arts Education can contribute to the sustainability of batik cultural heritage among Malaysian secondary school students.

Implications for Visual Arts Education and Heritage Sustainability

The findings of this study offer several important implications for the future development of Visual Arts Education and for the sustainability of cultural heritage within Malaysian secondary schools. First, the study highlights the need to reposition Visual Arts Education beyond its traditional emphasis on artistic skills and creative production towards a more holistic approach that integrates cultural literacy, heritage appreciation, and identity formation. The moderate level of awareness and low level of engagement observed among students suggest that existing approaches to teaching batik may not sufficiently foster meaningful connections between learners and cultural heritage. Consequently, educators should consider adopting heritage-based and culturally responsive pedagogical approaches that encourage students to critically explore the historical, social, and cultural significance of batik rather than focusing solely on technical competencies. Such an approach would enable students to develop a deeper understanding of batik as a living cultural heritage that continues to evolve within contemporary society. This aligns with the broader objectives of Visual Arts Education, which emphasise the development of creative, culturally informed, and socially responsible individuals capable of appreciating and sustaining cultural diversity (Smith & Campbell, 2023; Wang, 2019).

Second, the findings underscore the importance of strategically integrating digital technologies into Visual Arts Education to enhance students' engagement with cultural heritage. Positive perceptions of technology-enhanced learning indicate that digital tools can provide effective pathways for connecting younger generations with traditional cultural knowledge. Educational technologies such as digital storytelling, virtual exhibitions, augmented reality applications, multimedia learning resources, and digital design platforms can create more immersive and interactive learning experiences that resonate with contemporary learners. However, the findings also suggest that technology should not be viewed merely as an instructional tool but as a pedagogical medium that facilitates cultural exploration, creativity, and critical reflection. Therefore, curriculum developers and educators should focus on designing learning experiences that integrate technology, pedagogy, and cultural content in meaningful ways, consistent with the principles of the TPACK framework (Mishra & Koehler, 2006; Koehler et al., 2019). Such integration has the potential to strengthen students' cultural awareness while simultaneously developing digital competencies required for twenty-first-century learning.

From a broader cultural sustainability perspective, the findings demonstrate that schools can play a significant role in safeguarding intangible cultural heritage through educational innovation. The sustainability of batik heritage depends not only on preservation efforts by cultural institutions and artisan communities but also on younger generations' willingness to engage with, reinterpret, and transmit cultural knowledge. The relatively low level of participation identified in this study suggests that greater collaboration is needed between schools, cultural agencies, museums, heritage organisations, local communities, and batik practitioners. Such partnerships can provide students with authentic cultural experiences that bridge the gap between formal education and real-world cultural practices. Furthermore, policy initiatives related to cultural heritage education should encourage the development of digital heritage programmes that enable students to become active contributors to cultural preservation efforts. By positioning learners as creators, advocates, and cultural ambassadors, technology-enhanced Visual Arts Education can contribute not only to educational outcomes but also to the long-term preservation, transmission, and revitalisation of batik cultural heritage. Ultimately, the findings suggest that sustainable heritage education requires a balanced integration of culture, pedagogy, and technology to ensure that traditional knowledge remains relevant and meaningful within an increasingly digital and globalised society.

CONCLUSION

This study examined the role of technology-enhanced Visual Arts Education in supporting the sustainability of batik cultural heritage among Malaysian secondary school students. The findings revealed that students possessed a moderate level of awareness regarding batik as a cultural heritage asset and demonstrated relatively low engagement in batik-related activities. Nevertheless, students expressed highly positive perceptions towards the integration of digital technology within Visual Arts Education, indicating that technology-enhanced learning environments, such as the integration of computational thinking into visual arts instruction, can enhance the teaching and learning of artistic expression (Ibrahim & Ramli, 2024, pp. 10-20). considerable potential to

increase interest, participation, and appreciation of cultural heritage among younger generations. These findings suggest that while students generally recognise the importance of batik as part of Malaysian cultural identity, greater efforts are needed to transform awareness into meaningful engagement and active cultural participation.

The study further demonstrates that technology-enhanced learning can function as an important bridge between traditional cultural knowledge and contemporary youth culture. Through digital tools and interactive learning experiences, students are given new opportunities to access, explore, interpret, and communicate cultural heritage in ways relevant to their daily lives. However, the findings also indicate that technology alone cannot guarantee cultural sustainability. The effectiveness of technology integration depends on the extent to which digital tools are supported by appropriate pedagogical strategies and meaningful cultural content. In this regard, the Technological Pedagogical Content Knowledge (TPACK) framework provides a valuable foundation for understanding how to integrate technology, pedagogy, and heritage content to create effective, culturally meaningful learning experiences.

From a theoretical perspective, this study contributes to the growing body of literature on heritage education, technology-enhanced learning, and cultural sustainability by extending the application of the TPACK framework to cultural heritage preservation. The findings suggest that technology-enhanced Visual Arts Education can play a significant role not only in improving learning experiences but also in strengthening cultural awareness, heritage appreciation, and intergenerational transmission of cultural knowledge. The study therefore reinforces the view that educational institutions are important agents in safeguarding intangible cultural heritage through innovative and culturally responsive pedagogical practices.

Practically, the findings highlight the need for educators, curriculum developers, and policymakers to strengthen the integration of cultural heritage and digital technology within Visual Arts Education. Greater emphasis should be placed on experiential, participatory, and technology-supported learning activities that enable students to engage actively with batik as a living cultural heritage rather than merely as a historical artefact or classroom topic. Collaboration between schools, cultural institutions, museums, heritage organisations, and batik practitioners should also be expanded to provide students with authentic cultural learning experiences. Such efforts would contribute to the development of culturally informed, technologically competent, and socially responsible citizens capable of sustaining cultural heritage in the twenty-first century.

In conclusion, the sustainability of batik cultural heritage depends not only on preservation initiatives but also on education systems' ability to cultivate cultural awareness, appreciation, and engagement among younger generations. By integrating digital technologies within Visual Arts Education through meaningful pedagogical approaches, schools can contribute significantly to the preservation, transmission, and revitalisation of batik heritage. Ultimately, technology-enhanced Visual Arts Education offers a promising pathway for ensuring that batik remains relevant, valued, and sustainable within an increasingly digital and globalised world.

Declaration on the Use of Artificial Intelligence (AI)

During the preparation of this manuscript, ChatGPT was utilised as a supportive tool for language refinement, idea organisation, and academic writing editing. All content generated with the assistance of this tool was thoroughly reviewed, evaluated, and revised by the authors to ensure factual accuracy, academic appropriateness, and scholarly integrity. The authors assume full responsibility for the final content of this manuscript.

REFERENCES

1. Abdullah, A. H., Samin, M. A., & Legino, R. (2018). The design and identity of batik tulis products of selected batik manufacturers in Klang Valley. *Journal of Design and Built Environment*, 18(1), 45–54.
2. Akhir, N. H. M., Ismail, N. W., Said, R., & Kaliappan, S. R. A. (2015). Traditional craftsmanship: The origin, culture and challenges of batik industry in Malaysia. In R. Omar et al. (Eds.), *Islamic perspectives relating to business, arts, culture and communication* (pp. 235–246). Springer.
3. Anwar, M. S., Rahman, A., & Hossain, M. (2023). Digital technology and cultural heritage preservation in education. *Heritage Science*, 11(1), 121–134. <https://doi.org/10.1186/s40494-023-00921-5>

4. Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research. *Journal of Personality and Social Psychology*, 51(6), 1173–1182.
5. Choi, S., & Kim, H. (2022). Heritage-based learning in art education: Enhancing cultural awareness among students. *International Journal of Art & Design Education*, 41(3), 512–526. <https://doi.org/10.1111/jade.12410>
6. Class, B. (2024). Teaching research methods in education: Using the TPACK framework. *Educational Research Review*, 42, 100612.
7. Creswell, J. W., & Creswell, J. D. (2021). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.
8. Duncum, P. (2020). Visual culture in art education: Why, what and how. *International Journal of Art & Design Education*, 39(4), 685–697. <https://doi.org/10.1111/jade.12325>
9. Elkington, J. (1997). *Cannibals with forks: The triple bottom line of 21st century business*. Capstone.
10. Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2019). *A primer on partial least squares structural equation modeling (PLS-SEM)* (2nd ed.). SAGE Publications.
11. Harris, J., Mishra, P., & Koehler, M. J. (2009). Teachers' technological pedagogical content knowledge and learning activity types. *Journal of Research on Technology in Education*, 41(4), 393–416.
12. Huang, Y. (2024). Digital transformation frameworks for intangible cultural heritage sustainability. *Journal of Cultural Heritage*, 67, 145–158.
13. Kasemsarn, K., & Nickpour, F. (2025). Digital storytelling and cultural heritage engagement among youth. *Heritage*, 8(2), 112–129.
14. Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education*, 9(1), 60–70.
15. Koehler, M. J., Mishra, P., & Cain, W. (2019). What is technological pedagogical content knowledge (TPACK)? *Journal of Education*, 193(3), 13–19. <https://doi.org/10.1177/002205741319300303>
16. Lian, S. (2022). Digital heritage and education: Opportunities for cultural sustainability. *Journal of Cultural Heritage*, 55, 221–229. <https://doi.org/10.1016/j.culher.2022.02.012>
17. Logan, W. (2020). Cultural heritage, identity and youth engagement in the era of globalization. *International Journal of Heritage Studies*, 26(9), 911–925. <https://doi.org/10.1080/13527258.2020.1762473>
18. Madgin, R., Lesh, M., & Jørgensen, A. (2016). New approaches to heritage and young people. *International Journal of Heritage Studies*, 22(6), 481–492.
19. McCarthy, A. M., Murphy, E., & Smith, T. (2023). Digital transformation in education: Critical components for successful change. *Social Sciences & Humanities Open*, 8(1), 100691.
20. Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), 1017–1054. <https://doi.org/10.1111/j.1467-9620.2006.00684.x>
21. Mohamed, N., Rahman, N. A., & Hassan, H. (2018). Creative industries and cultural sustainability in Malaysia. *Journal of Cultural Economics*, 42(4), 589–607.
22. Noor Haslina Mohamad Akhir, N., & Ismail, N. W. (2015). Permasalahan dalam pembangunan industri batik di Terengganu. *Malaysian Journal of Society and Space*, 11(9), 45–56.
23. Nuringsih, K. (2021). Maintaining the sustainability of local cultural wisdom in batik. *Advances in Social Science, Education and Humanities Research*, 561, 120–128.
24. OECD. (2025). *Digital education outlook 2025: Technology and the future of learning*. OECD Publishing.
25. Pallant, J. (2020). *SPSS survival manual* (7th ed.). McGraw-Hill Education.
26. Petko, D. (2025). TPACK in context: An updated model. *Computers and Education Open*, 6, 100192.
27. Rahman, M., & Hashim, S. (2020). Heritage education and cultural transmission in Malaysian schools. *International Journal of Education and Culture*, 8(2), 33–48.
28. Razali, H. M., Ibrahim, M., Omar, M., & Hashim, S. F. M. (2021). Current challenges of the batik industry in Malaysia and proposed solutions. *Journal of Cultural Heritage Management and Sustainable Development*, 11(3), 273–289. <https://doi.org/10.1108/JCHMSD-07-2020-0102>
29. Redecker, C. (2021). Digital education and learning transformation in schools. *Computers & Education*, 166, 104158. <https://doi.org/10.1016/j.compedu.2021.104158>

30. Rizvic, S., Okanovic, V., Boskovic, D., & Skalonja, U. (2020). Interactive digital storytelling for cultural heritage presentation. *Journal on Computing and Cultural Heritage*, 13(3), 1–19.
31. Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.
32. Salma, I. I. R., & Eskak, E. (2020). Keeping the genuine of batik in the age of artificial intelligence. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3807704>
33. Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. (2009). Technological pedagogical content knowledge (TPACK): The development and validation of an assessment instrument for preservice teachers. *Journal of Research on Technology in Education*, 42(2), 123–149.
34. Shan, W. (2025). Youth engagement with visual arts intangible cultural heritage. *Malaysian Journal of Social Sciences and Humanities*, 10(3), 55–69.
35. Shaari, N., Saidon, I., & Abdullah, M. (2017). Sustaining batik craft design in Malaysia using indigenous knowledge. *Pertanika Journal of Social Sciences and Humanities*, 25(S), 95–110.
36. Smith, L., & Campbell, G. (2023). Heritage education and cultural sustainability in contemporary learning environments. *Sustainability*, 15(4), 3128. <https://doi.org/10.3390/su15043128>
37. Soini, K., & Dessein, J. (2016). Culture–sustainability relation: Towards a conceptual framework. *Sustainability*, 8(2), 167. <https://doi.org/10.3390/su8020167>
38. Stephens-Himonides, C. (2025). Adding to the knowledge of the TPACK framework: A case study. *Frontiers in Education*, 10, 1522739.
39. Sugiarto, E. (2025). How is ethnopedagogy-based education implemented? *Cogent Education*, 12(1), 2466245.
40. Taber, K. S. (2018). The use of Cronbach’s alpha when developing and reporting research instruments in science education. *Research in Science Education*, 48(6), 1273–1296. <https://doi.org/10.1007/s11165-016-9602-2>
41. Teece, D. J. (2007). Explicating dynamic capabilities. *Strategic Management Journal*, 28(13), 1319–1350.
42. Timotheou, S., Miliou, O., Dimitriadis, Y., Sobrino, S. V., Giannoutsou, N., Cachia, R., ... & Ioannou, A. (2022). Impacts of digital technologies on education and factors influencing schools’ digital capacity and transformation. *Education and Information Technologies*, 28(6), 6695–6726.
43. UNESCO. (2023). *Culture and digital technologies for cultural heritage sustainability*. UNESCO Publishing.
44. UNESCO. (2024). *Education for sustainable development and cultural heritage preservation*. UNESCO Publishing.
45. Wang, C. Y. (2019). Building a network for preserving intangible cultural heritage through education: A study of Indonesian batik. *International Journal of Art & Design Education*, 38(2), 398–415. <https://doi.org/10.1111/jade.12200>
46. Xingyun, L., & Widiyanah, I. (2026). The role of art education in safeguarding intangible cultural heritage. *MISRO Journal of Arts and Education*, 4(1), 22–39.
47. Zhang, X., & Kaya, A. (2023). Youth participation in cultural heritage management and sustainability. *Journal of Cultural Heritage*, 61, 90–101.