Development of Pedagogical Digitalization Components for Visual Arts Education in Primary Schools: A Fuzzy Delphi Method

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ABSTRACT

The integration of digital pedagogical approaches has emerged as a fundamental imperative in 21st-century educational transformation, aligning with both the Sustainable Development Goals (SDGs) and Digital Education Policy frameworks, particularly within the domain of Visual Arts Education (VAE) at the primary education level. This research endeavors to examine the systematic development of digitalized pedagogical frameworks for Visual Arts Education in primary institutions, utilizing the Fuzzy Delphi methodology to enhance instructional efficacy and learning outcomes. The implementation of the Fuzzy Delphi method facilitates the synthesis of expert consensus in establishing critical components for pedagogical digitalization that address both educator and learner requirements. The empirical findings demonstrate the efficacy of the Fuzzy Delphi approach in ensuring the pedagogical digitalization framework maintains contextual relevance and appropriateness within the primary school teaching environment.

Keywords: Pedagogical Digitalization, Fuzzy Delphi, Visual Arts Education, Primary School.

INTRODUCTION

Digitalization in education has become a global phenomenon, with various countries implementing digital technology to enhance teaching and learning effectiveness (Osmani & Tartari, 2024). In Malaysia, the Malaysia Education Blueprint (MEB) 2013-2025 has emphasized technology integration as a crucial element in achieving 21st-century educational goals (Ministry of Education Malaysia, 2017). Initiatives such as the use of online learning platforms, mobile applications, and multimedia resources have strengthened students' learning experiences (M. Zhou, 2023). These technologies not only improve access to education but also enrich learning content with interactive and visual elements (Anghelo Josué et al., 2023).

At the international level, countries like Finland and Singapore have demonstrated success in integrating digital technology into their education systems (Haoning Mah et al., 2021). Research by Kangas and Rasi (2021) found that Finland has introduced the concept of "phenomenon-based learning" which uses technology to enable students to explore topics across various disciplines. Meanwhile, in the study by L. S. Sun and Shah (2022), Singapore has leveraged technology by launching initiatives such as "Smart Nation" which encompasses smart education and digital skills development from early schooling.

In the context of Visual Arts Education (VAE), digitalization provides extensive opportunities for students to explore their creativity through the use of tools such as digital art applications, virtual reality simulations, and collaborative platforms (Puadi & Hashim, 2024). Through this approach, Suhaila Mohd Saleh and Sabri (2024) believe that students not only learn to appreciate art but also develop 21st-century skills such as problem-solving, critical thinking, and collaboration

LITERATURE REVIEW

The Evolution of Pedagogical Digitalization

Since the technological revolution era, pedagogical digitalization has rapidly developed worldwide (Bitar & Davidovich, 2024). In its early stages, the use of technology in education focused on tools such as computers and basic software (Sani et al., 2024). However, with advances in information and communication technology, the concept of digitalization has expanded to include web-based learning, mobile applications, and the use of artificial intelligence (AI) and virtual reality (VR) (Irsyad et al., 2024). Studies by Idowu Sulaimon Adeniyi et al. (2024) and Md. Shahdat Hossain Munna et al. (2024) state that countries like the United States and South Korea have pioneered educational digitalization through the implementation of large-scale online learning platforms and learning management systems (LMS).

In Europe, many schools and educational institutions have integrated technology as a primary tool for interactive teaching (Osmani & Tartari, 2024). For example, in the United Kingdom, the "EdTech Strategy" initiative has introduced smart technology to enhance learning effectiveness in classrooms (X. Sun & Jiang, 2023). In Asian countries like Japan and China, pedagogical digitalization has been enriched with gamification elements and personalized learning to meet diverse student needs (S. Zhou, 2024). This reflects the evolution of pedagogy that not only relies on technology as a support tool but as a key catalyst for global educational transformation

Digitalization of Pedagogy in Education

The findings of a study by Ida Puteri Mahsan (2021), explain that Visual Arts Education in primary schools plays an important role in fostering creativity and aesthetic values among young students. The digitization of pedagogy has opened up wider opportunities to integrate technology in the teaching and learning process (Lim et al., 2024). Through global initiatives such as the Sustainable Development Goals (SDGs), specifically SDG 4: Quality Education, the digitalisation of pedagogy supports the goal of ensuring inclusive and equitable education and promoting lifelong learning opportunities (Nanjundaswamy et al., 2021). Technologies such as mobile apps, virtual reality (VR), and digital learning platforms allow students to explore the visual arts in a more dynamic and interactive way (Safar & Abdul Raman, 2021).

Nevertheless, the challenges in implementing pedagogical digitalization in the context of Visual Arts Education cannot be ignored. In Malaysia, although the Digital Education Policy provides a strong framework, its implementation is often confronted with issues such as the lack of technological infrastructure in rural schools, varying levels of digital literacy of teachers, and the difficulty of obtaining relevant digital materials for the visual arts (Aminamul Saidah Mad Nordin et al., 2023). Furthermore, the limited education budget to equip equipment such as tablets or computers is also an obstacle to the effectiveness of this initiative (Aliya et al., 2024).

The effectiveness of Digital Education Policies also requires ongoing training and professional development support for teachers (Jalil, 2024). Teachers need to be trained not only in the use of technology but also in applying digital pedagogy that is appropriate for visual arts (Jalil, 2024). Without adequate support, pedagogical digitization has the potential to become an additional burden on teachers, rather than a facilitator (Wong et al., 2024). Therefore, this study aims to develop the digitalization of the pedagogy of Visual Arts Education teaching and learning based on the perspective of experts to answer the following research questions:

1. What is the order of priorities for each of the main components of the development of digitalization of pedagogy teaching and learning of primary school Visual Arts Education subjects based on expert consensus?

METHODOLOGY

This study uses a qualitative approach to develop the digitalization of the pedagogy of Visual Arts Education in teaching and learning based on the perspective of experts. This study focuses on the development phase to

identify the priority sequence of components in developing pedagogical digitization materials. This phase is a critical initial step before moving on to the implementation phase. The selection to focus on the development phase is based on the need to form a solid foundation in identifying the key components needed in the digitalization of primary school Visual Arts Education pedagogy

Research Design

This study uses a qualitative research design using the Fuzzy Delphi method. This approach was chosen to obtain a priority order of elements for each major component of the development of digitalization, pedagogy, teaching and learning subjects, Visual Arts Education, in primary schools based on expert consensus.

Sample

A total of 20 panelists were selected as participants in the research using the purposive sampling method. The sample involves a panel of experts appointed according to the expertise and suitability of the research. To ensure that the panel experts involved can contribute to the accuracy of information to the research, the selection of panel experts must meet the criteria that have been set. The selected research participants consisted of professional individuals in the fields of Visual Arts Education, Learning Technology and Multimedia Graphic Design. The determination of the number of experts on the research panel is as proposed by Jones & Twiss, 1978 which is 10 to 50 experts and Adler & Ziglo, 1996 which is 10 to 15 experts. The selection of a panel of 20 experts is in line as recommended is sufficient to obtain authentic findings. The choice to rely on the views of experts rather than consumers is because the appointed experts have in-depth expertise in this field and are able to provide a more comprehensive view based on their experience and knowledge in the fields of Visual Arts Education, Learning Technology and Multimedia Graphic Design.

Instrument

The instrument was use a set of FDM questionnaires. This instrument set was produced through NGT workshop sessions based on a consensus process of an expert panel. This FDM question form instrument uses seven (7) FDM likerts scales. Table 1 is the interpretation of the likert scale for the acceptance of the main components and elements based on a study by Abdul Muqsith Ahmad (2018) and Yusoff (2022) used by the researchers.

Tabel 1: Likert Scale Interpretation Level

Likert Scale	Interpretation
1	Strongly Disagree
2	Disagree
3	Partially Disagree
4	Neutral
5	Partially Agree
6	Agree
7	Strongly Agree

Data Analysis

Data was collected through the distribution of questionnaires conducted online by sending emails to research participants. The data was analyzed using Microsoft Excel FDM software.

FINDING AND DISCUSSION

The Components of Digitalization Pedagogy of Visual Arts Education Teaching and Learning in Primary Schools.

The findings of the research were to determine the order of priorities, positions, and key components in developing the digitalization of the pedagogy of Visual Arts Education teaching and learning in primary schools. The data is to answer the question of what is the order of priorities of the elements for each of the main components of the development of digitalization of the pedagogy of teaching and learning of Visual Arts Education subjects in primary schools based on the consensus of the panel experts. The data to be analyzed must meet the three conditions that have been specified in FDM using Microsoft Excel FDM version 1.5 software. Figure 1 is the expert consensus requirements meet triangular fuzzy numbers requirements are (1) *Triangular Fuzzy Number* to get the threshold value, *(d)*. The condition that needs to be met is that the *threshold value, (d)* obtained must be less than or equal to the value of ≤ 0.2, (Cheng & Lin, 2002), then all experts have reached a consensus. Subsequently (2) The percentage of expert consensus for the value of the percentage of expert consensus is equal to or above ≥ 75% (Chu & Hwang, 2008; Murry & Hammons, 1995) shows that the consensus of the expert panel is adhered to. And finally (3) *Defuzzification Process*, which is a fuzzy evaluation process to determine the value of the Fuzzy score and the priority of the position of each element in each main component is based on the value of the fuzzy score, α-cut. Fuzzy, α-cut score values equal to or greater than 0.5 are acceptable while less than 0.5, α ≥ 0.5 (Tang & Wu, 2010; Bodjanova, 2006), then the component or element was rejected based on the agreement of the expert panel. The following are the findings to determine the order of priority of the main components and elements in developing the digitalization of the pedagogy of Visual Arts Education teaching and learning in primary schools.

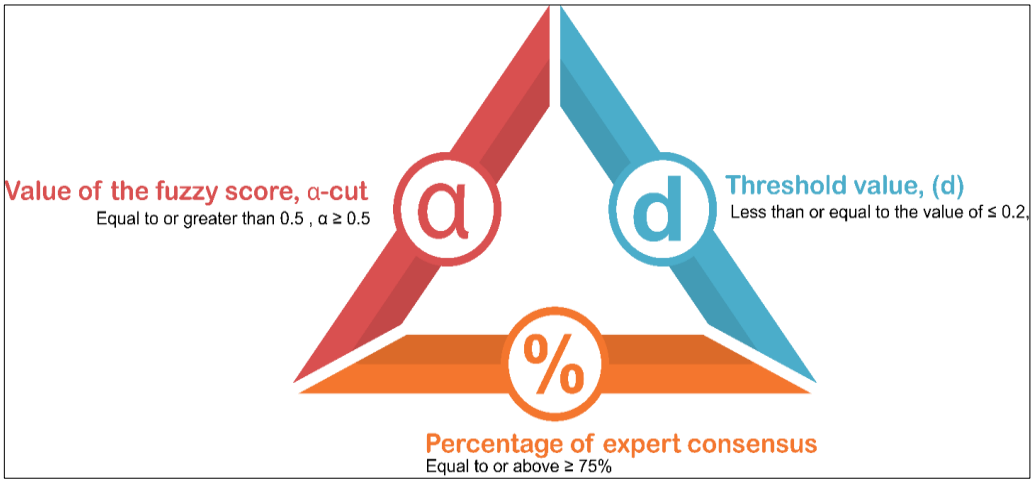

Fig. 1 Graphical of Expert Consensus Requirements Meet Triangular Fuzzy Numbers Requirement

Tabel 2: Main Components and Elements of Pedagogical Digitalization for Teaching and Learning Visual Arts Education in Primary Schools

Components	Elements	Fuzzy Score	Ranking
Hardware Selection	Smartphone	0.923	1
	Laptop	0.912	2
Platform Selection	Android	0.952	1
	IOS	0.918	2
Learning Objectives	Objectives based on SK/SP	0.962	1

	DSKP as a guide and reference set objectives	0.957	2
Learning Content	Interactive presentation of learning material content.	0.962	1
	The presentation of material content is informative, clear and easy to understand	0.957	2
Learning Activities	Selection of activities that are suitable for learning objectives.	0.957	1
	Implementation of activities that allow students to learn independently.	0.952	2
Learning Assessment	Assessment instruments apply motivation towards student achievement.	0.967	1
	Assessment instruments based on learning activities.	0.962	2
Interface Design	Selection of color schemes that match the content.	0.962	1
	Clear content layouts make it easy for users to understand.	0.957	2
Interactive Multimedia	Graphics, illustrations and images that help deliver learning.	0.953	1
	The use of text forms that are easy to understand and appropriate.	0.952	2

The findings in Table 2 show the priority order of eight main components and elements that are priorities for the study of pedagogical digitalization in teaching and learning Visual Arts Education in primary schools. Smartphones with the highest score (0.923) demonstrate their relevance in supporting mobile learning. However, challenges such as internet connection stability and small screen size may affect user experience. For platforms, the prioritized Android (0.952) shows flexibility and affordability, but the diversity in device quality raises questions about user experience consistency. Meanwhile, objectives based on Standard Content/Standard Learning (0.962) are important in providing accurate guidance to students, but their effectiveness depends on consistent assessment strategies. Furthermore, interactive learning material content presentation (0.962) is a priority in attracting interest and focus, while teaching materials need to be adapted to various learning styles.

In terms of learning activities, the selection of activities that are suitable for learning objectives (0.957) has great potential to increase students' interest but requires a balance between entertainment and learning substance. In addition, the assessment instrument applies motivation towards student achievement (0.967) emphasizing the need to support the development of students' self-motivation to keep trying. Still, this element needs to be combined with formative evaluation that allows for continuous improvement.

Furthermore, the interface design through the selection of color schemes that are suitable for the content (0.962), is able to improve the overall learning experience that can attract students' attention to continue to be paired with interactive Multimedia components through graphics, illustrations and pictures that help learning delivery (0.953). Overall, this study not only highlights the potential of digitalization technology in education but also to ensure that pedagogical digitization provides maximum benefits to teaching and learning. The main component

of pedagogical digitalization in teaching and learning Visual Arts Education in primary schools shown on Figure 2.

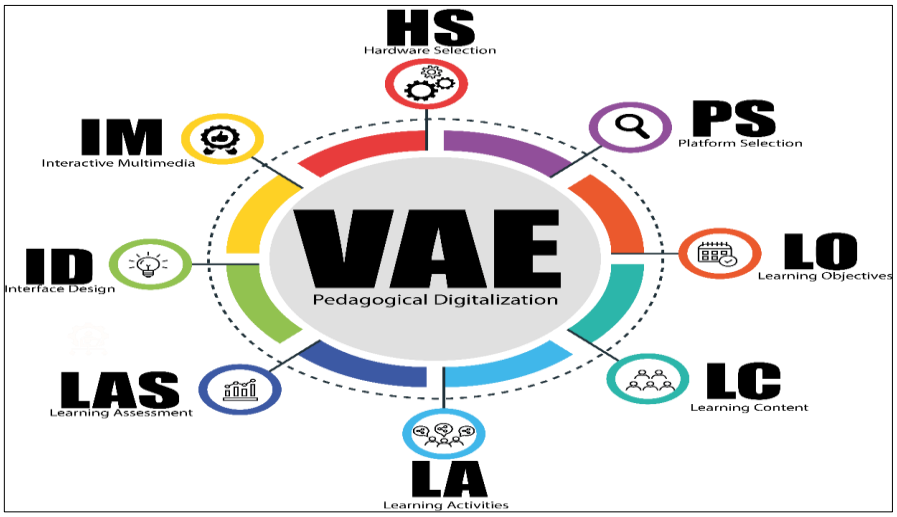

Fig. 2 Main Component of Pedagogical Digitalization in Teaching and Learning Visual Arts Education in Primary Schools

The Relationship Between Components of Digitalization Pedagogy of Visual Arts Education Teaching and Learning in Primary Schools.

Based on the findings of the study Figure 2 shows that the relationship between the main components has been identified in the development of pedagogical digitization for Visual Arts Education.Eight main components have been identified in the development of pedagogical digitalisation for Visual Arts Education. These components are categorized into three main groups. The first category, Technical Components, involves the selection of appropriate hardware and platforms, which is essential to ensure that the implementation runs smoothly. The second category, the Pedagogical Component, includes learning objectives, content, activities, and assessments, which form the basis of an effective teaching and learning process. The third category, Design Components, covers interface design and interactive multimedia elements, which are crucial for enhancing students' learning experience. All of these components exhibit a high Fuzzy score (above 0.9), signifying the critical importance of each component in the development of effective pedagogical digitalization.

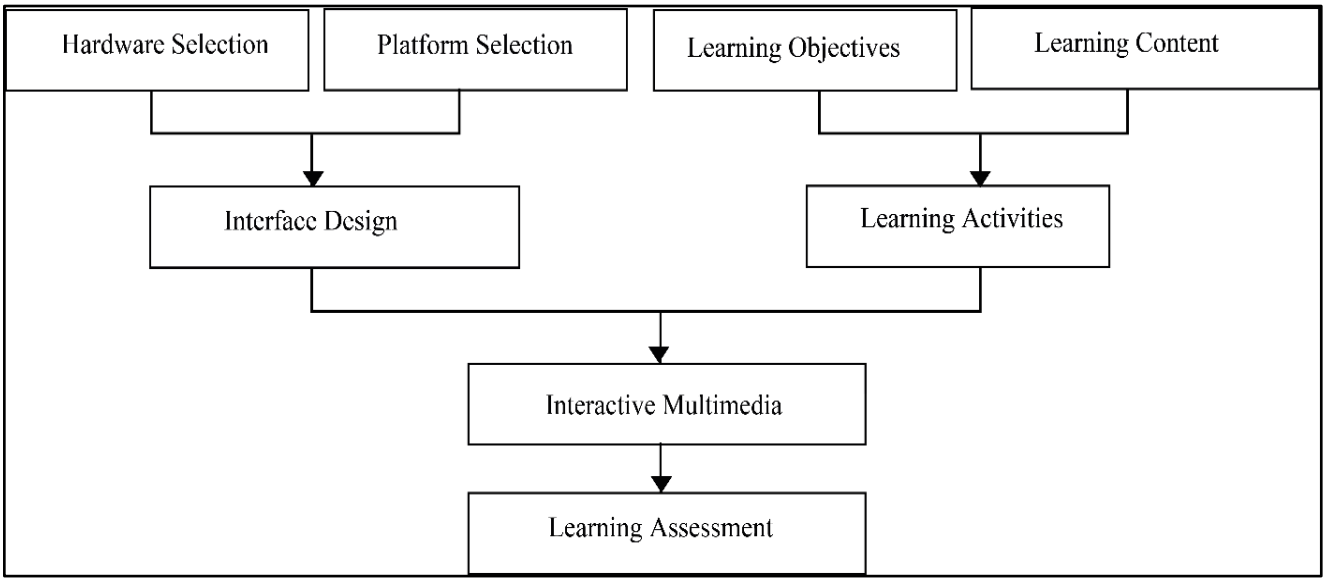

Fig. 2 The Relationship Between Components of Digitalization Pedagogy of Visual Arts Education Teaching and Learning in Primary Schools.

Fuzzy Score of the Component in Pedagogical Digitalization for Visual Arts Education in Primary Schools

The results of Fuzzy Delphi's score analysis in figure 3 show the position and importance of each component in the development of pedagogical digitalization for Visual Arts Education. Figure 3 show all components achieved a high Fuzzy score (>0.9), indicating a significant level of agreement among the expert panel. These components can be grouped into three main categories. The first category, Technical Components, covers the hardware and platform aspects that provide the infrastructure foundation for implementation. This component recorded a score between 0.912 to 0.952, signaling its critical role. The second category, the Pedagogical Component, covers the four main elements of learning and recorded the highest score, which is 0.967 for the learning assessment element. This shows that the pedagogical component is at the core of an effective teaching and learning process. The third category, Design Components, focuses on user experience and achieves a high consistent score (0.952-0.962). This emphasizes its importance in improving learning effectiveness. The overall analysis reinforces the role of the three main components in supporting the development of high-impact pedagogical digitalisation in Visual Arts Education.

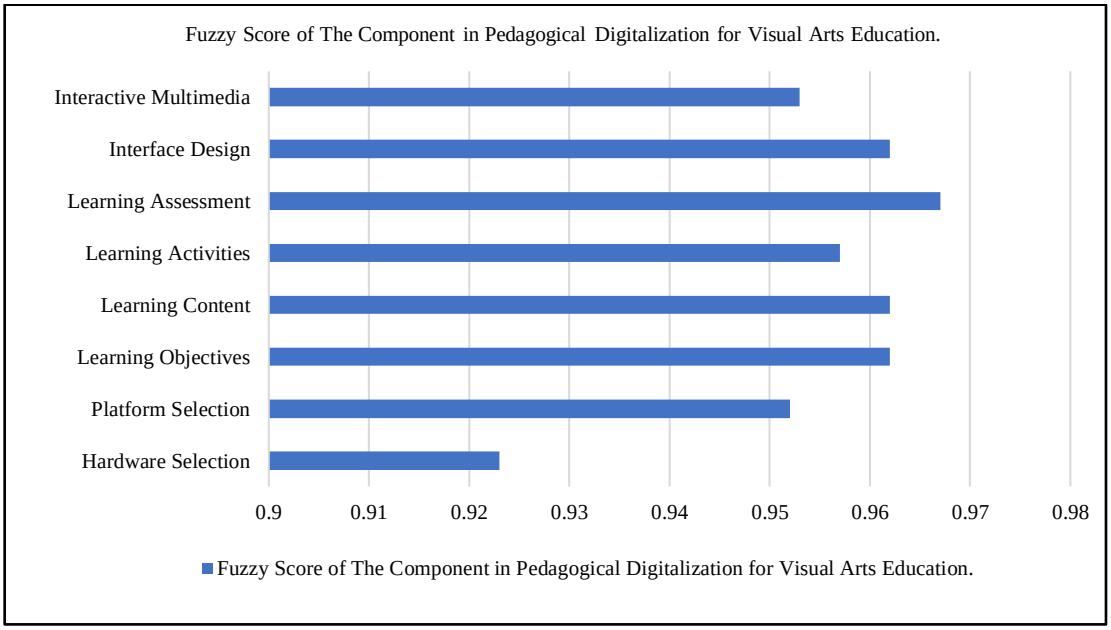

Fig. 4 Fuzzy Score of The Component in Pedagogical Digitalization for Visual Arts Education

Although the findings of the study show a high consensus among experts on the key components of pedagogical digitalisation, the implementation of these components requires consideration of a number of challenges and strategies to overcome. The main challenges identified include the issue of technological infrastructure, especially in rural areas that may face limited internet access and digital facilities. Strategies proposed to overcome these challenges include the phased implementation according to the readiness of schools and the use of applications that can work in offline mode.In terms of teachers' digital competence, the need to improve technology skills among educators is a challenge that needs to be addressed systematically. Ongoing training programs and the development of professional learning communities can help teachers master the skills needed to integrate technology in visual arts instruction. In addition, the provision of self-paced learning modules for teachers can help them continuously improve their skills according to their respective levels and needs.The third challenge to pay attention to is the adaptation of pedagogy to ensure a balance between traditional and digital teaching. This is important to ensure that the practical aspects of visual arts are not overlooked in the digitization process. A blended learning approach that combines traditional and digital methods can be an effective solution. The development of flexible teaching modules and a wide selection of learning activities can cater to the needs of students of different skill levels.Finally, the cost and sustainability aspects of digitalization programs need to be considered for long-term success. The use of open-source software and resource sharing between schools can reduce operating costs. Partnering with higher education institutions for the development of digital learning materials can also help reduce the financial burden on schools. The proposed implementation strategy includes three phases: short-term focusing on the use of basic applications and teacher training; medium-term involving

infrastructure improvement and community development of practice; and long-term that targets the development of a sustainable digital ecosystem in Visual Arts Education.

CONCLUSION

This research has elucidated the priorities of elements in developing digital pedagogical frameworks for Visual Arts Education at the primary school level. Through the systematic application of the Fuzzy Delphi methodology, expert consensus was achieved regarding critical components encompassing hardware infrastructure selection, platform optimization, learning objective formulation, content development, pedagogical activities, assessment mechanisms, interface design principles, and interactive multimedia integration. Empirical findings demonstrate that the combination of appropriate technological implementation, user-centric interface design principles, and pedagogically sound interactive content serves as crucial determinants in optimizing the effectiveness of teaching and knowledge acquisition in Visual Arts Education. The research also found that the integration of motivationally aligned learning activities and robust assessment instruments plays a vital role in enhancing student engagement metrics and academic performance outcomes.

Regarding technological components, the study highlights the importance of selecting hardware infrastructure suitable for primary school needs, optimized platforms for visual arts instruction, effective interactive multimedia integration, and user-friendly interface design. The pedagogical aspect emphasizes the importance of clear learning objective formulation, development of age-appropriate content, engaging and interactive learning activities, and effective immediate assessment. The identified learning impacts include increased student engagement in learning, improved academic achievement, deeper understanding of visual arts concepts, and enhanced learning motivation. In terms of long-term outcomes, this framework supports the development of digital skills, enhancement of creativity and innovation, development of 21st-century competencies, and cultivation of interest in visual arts.

However, several challenges were identified in implementing this framework, including technological infrastructure issues, the need to enhance teachers' digital competencies, the importance of ensuring accessibility for all students, and the need to maintain teaching and learning quality. Solutions to these challenges require a comprehensive approach and continuous support from various stakeholders. In conclusion, this research provides strong empirical evidence regarding the importance and effectiveness of digital pedagogical frameworks in Visual Arts Education. These findings have important implications for education policymakers, school administrators, and teachers in planning and implementing more effective visual arts education programs aligned with modern educational needs. The successful implementation of digital pedagogical frameworks requires a holistic approach that considers technological aspects, pedagogy, and user needs, including continuous professional development for teachers, adequate infrastructure support, and ongoing evaluation for system improvement.

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