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Research Article

STEAM and the Innovation of Art Teacher Education in Vietnamese Pedagogical Universities in the Digital Era

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Abstract:

This study investigates the integration of STEAM (Science, Technology, Engineering, Arts, and Mathematics) into art teacher education in Vietnamese universities with arts programs, aiming to enhance creativity and teaching effectiveness through digital transformation. The research objectives are to evaluate the perceptions of students and educators regarding STEAM's benefits, identify barriers to its implementation, and propose strategies for curriculum reform to align with 21st-century educational demands. A mixed-methods approach was employed, involving 195 participants (150 students and 45 lecturers/managers) from the Military University of Culture and Arts and Hanoi National University of Education. Data were collected via surveys with Likert-scale and open-ended questions, supplemented by semi-structured interviews with 20 participants, and analyzed using SPSS for quantitative data and thematic analysis for qualitative insights. The findings indicate strong support for STEAM's role in fostering creativity ($M = 4.2$ for students, $M = 4.5$ for lecturers/managers, $p = 0.03$) and enhancing teaching effectiveness through digital tools ($M = 4.0$ and 4.3, $p = 0.04$). However, significant challenges, including resource constraints ($M = 4.1$ and 4.4) and inadequate faculty training ($M = 2.8$ and 3.1), were identified, with qualitative data highlighting issues such as outdated technology and limited digital literacy. The study concludes by advocating for curriculum reform, increased investment in digital tools, and targeted faculty training to prepare art teachers for innovative, technology-driven pedagogy, with recommendations for future research to explore longitudinal impacts and scalability of STEAM practices in Vietnamese higher education.

1. Introduction

The integration of STEAM (Science, Technology, Engineering, Arts, and Mathematics) education has emerged as a transformative approach in global education systems, fostering interdisciplinary learning and creativity in teacher education programs. In Vietnam, where traditional pedagogical methods have historically dominated, the adoption of STEAM represents a significant shift toward innovative and holistic education, particularly in the context of art teacher education.

This approach not only enhances students' technical skills but also cultivates creativity and critical thinking, which are essential for addressing the demands of the digital era [6]. The inclusion of arts in STEAM frameworks emphasizes the role of creativity in fostering innovation, making it particularly relevant for art education in Vietnamese pedagogical universities [8, 2].

In the digital era, the transformation of higher education through technology has reshaped teaching and learning methodologies. Digital tools and platforms have enabled new forms of engagement, allowing educators to integrate STEAM principles into art education more effectively [4]. In Vietnam, pedagogical universities such as the Military University of Culture and Arts and Hanoi National University of Education are beginning to explore STEAM as a means to modernize art teacher training, aligning with global trends in teacher education [5]. However, challenges such as limited resources, traditional mindsets, and the need for professional development in digital competencies persist [11].

This study aims to investigate the innovation of art teacher education through STEAM integration in Vietnamese pedagogical universities, focusing on the role of digital transformation. By examining the perspectives of students, lecturers, and education managers, the research seeks to understand how STEAM can enhance art education and prepare teachers for the demands of the 21st century [13]. The findings are expected to contribute to the development of effective STEAM-based curricula and inform policy-making in Vietnamese higher education.

2. Literature Review

2.1 STEAM Education

STEAM education, encompassing Science, Technology, Engineering, Arts, and Mathematics, represents a progressive educational framework that integrates interdisciplinary learning to foster creativity, innovation, and problem-solving skills. Unlike traditional STEM education, which focuses primarily on technical disciplines, STEAM incorporates the arts to promote holistic development and creative thinking, enabling students to address complex real-world challenges through diverse perspectives [6]. In Vietnam, STEAM has gained traction as a transformative approach, particularly in secondary education, where it encourages students to blend artistic creativity with scientific inquiry, fostering skills like critical thinking and collaboration [8]. Studies highlight that STEAM education creates dynamic learning environments that promote student engagement through project-based and experiential learning activities [2]. However, implementing STEAM in Vietnam faces significant challenges, including a lack of trained educators, limited access to modern resources, and resistance to moving away from traditional teaching methods. These barriers hinder the full realization of STEAM's potential to revolutionize education in the Vietnamese context [11]. Addressing these challenges requires targeted teacher training and investment in educational infrastructure to ensure STEAM's effective integration across various educational levels.

2.2 Global Trends in STEAM-Based Teacher Education

Globally, STEAM-based teacher education has emerged as a critical strategy to prepare educators for the demands of 21st-century classrooms, emphasizing interdisciplinary teaching that integrates creativity with technical skills. Teacher education programs worldwide are increasingly incorporating STEAM to equip educators with the ability to design innovative, project-based curricula that blend artistic and scientific approaches [5]. Research indicates that STEAM teacher training enhances educators' capacity to foster creativity and adaptability in students, preparing them for dynamic, technology-driven learning environments [4]. For instance, countries like Australia and Taiwan have successfully implemented STEAM teacher education models that emphasize experiential learning and immersive teaching practices, which enhance teacher identity development and professional growth [7, 12]. These global models provide valuable insights for Vietnam, where pedagogical universities are beginning to explore STEAM to modernize teacher training. However, challenges such as aligning global best practices with local cultural and educational contexts remain [13, 3]. Adopting these trends requires Vietnamese institutions to invest in professional development programs and foster collaborations with international STEAM education experts to enhance teacher competencies.

2.3 Art Education in Pedagogical Universities

Art education in pedagogical universities is pivotal in preparing teachers to cultivate creativity and cultural awareness among students, particularly in preserving Vietnam's rich artistic heritage while adapting to modern educational demands. Traditionally, Vietnamese art education has focused on cultural forms like Hat Trong Quan singing,

emphasizing the preservation of national identity through artistic expression [1]. However, the integration of STEAM into art education offers opportunities to modernize curricula by combining traditional artistic practices with technological and interdisciplinary approaches [10]. This shift enables art teachers to foster creativity while equipping students with digital and analytical skills relevant to contemporary society. Despite these opportunities, Vietnamese pedagogical universities face challenges such as outdated curricula, limited access to digital tools, and a lack of faculty training in STEAM methodologies [9]. Overcoming these barriers requires significant reforms, including curriculum updates and investments in professional development to align art education with global standards. Such efforts are essential to prepare art teachers who can inspire innovation and creativity in their students while maintaining cultural relevance [2].

2.4 Digital Transformation in Higher Education and Teacher Training

Digital transformation has fundamentally reshaped higher education by introducing advanced technologies that enhance teaching and learning processes, particularly in teacher training programs. In the context of STEAM education, digital tools such as virtual learning platforms, simulations, and interactive media have revolutionized how educators engage with interdisciplinary curricula, fostering dynamic and accessible learning environments [4]. In Vietnam, digital transformation is gradually being integrated into pedagogical universities, enabling teacher training programs to incorporate STEAM principles through blended learning and digital literacy initiatives [13]. However, challenges such as inadequate technological infrastructure, limited faculty expertise in digital tools, and resistance to change pose significant obstacles to effective implementation [11]. Research emphasizes that digital transformation can enhance STEAM-based teacher education by providing opportunities for collaborative learning and real-time feedback, which are critical for preparing art teachers to navigate the complexities of the digital era [9]. To fully leverage these benefits, Vietnamese institutions must prioritize investments in technology and faculty training to ensure educators are equipped to integrate digital tools effectively into STEAM-based art education.

3. Methodology

The study adopted a mixed-methods research design, integrating qualitative and quantitative approaches to thoroughly investigate the integration of STEAM in art teacher education within Vietnamese pedagogical universities. This approach facilitated a comprehensive analysis by combining numerical data with in-depth contextual insights, ensuring a robust exploration of the research problem. The quantitative component provided measurable data on participants' perceptions, while the qualitative approach captured nuanced perspectives on the challenges and opportunities of STEAM implementation in the digital era.

The research involved 195 participants, comprising 150 students and 45 university lecturers and education managers from the Military University of Culture and Arts and Hanoi National University of Education in Vietnam. The student participants were enrolled in art education programs, while the lecturers and managers were actively engaged in curriculum design or STEAM-related initiatives. This diverse participant group ensured a wide range of viewpoints, reflecting both learner and educator experiences in the context of modern pedagogical training.

Data were collected through surveys and semi-structured interviews. Surveys were distributed to all 195 participants to gather quantitative data on their attitudes, challenges, and perceived benefits of STEAM integration in art teacher education. The survey included Likert-scale questions and open-ended items to capture both structured and exploratory responses. Additionally, semi-structured interviews were conducted with a subset of 20 participants (10 students and 10 lecturers or managers) to explore their experiences and the practical implications of STEAM in greater depth. Interviews were audio-recorded and transcribed verbatim to ensure accuracy.

Data analysis was conducted in two phases. Quantitative survey data were analyzed using the Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics, such as means, standard deviations, and frequency distributions, were used to summarize participants' responses, while inferential statistics, including chi-square tests and t-tests, were applied to identify significant differences and relationships within the data. Qualitative data from interviews and open-ended survey responses were analyzed thematically, with coding and categorization performed to identify key themes and subthemes related to STEAM implementation and digital transformation. The integration of quantitative and qualitative findings through triangulation enhanced the validity and reliability of the study's conclusions, providing a

comprehensive understanding of the research objectives.

4. Findings

The findings of this study, derived from a mixed-methods approach, provide a comprehensive understanding of the integration of STEAM in art teacher education within Vietnamese pedagogical universities. The analysis of quantitative survey data and qualitative interview responses revealed key insights into participants' perceptions, challenges, and perceived benefits of STEAM implementation in the digital era. The results are presented below, combining statistical outcomes from SPSS analysis with thematic insights from qualitative data.

4.1 Quantitative Findings

The survey responses from 195 participants (150 students and 45 lecturers/education managers) were analyzed using SPSS to assess attitudes toward STEAM integration, perceived benefits, and challenges. Table 1 summarizes the key quantitative findings based on Likert-scale responses (1 = Strongly Disagree, 5 = Strongly Agree).

The data indicate that both students and lecturers/managers strongly agreed that STEAM enhances creativity in art education (M = 4.2 and 4.5, respectively), with a statistically significant difference ($p = 0.03$) suggesting lecturers/managers held slightly more positive views. Similarly, both groups acknowledged the role of digital tools in improving teaching effectiveness (M = 4.0 and 4.3, $p = 0.04$). However, participants identified a lack of resources as a significant barrier (M = 4.1 and 4.4), though the difference between groups was not statistically significant ($p = 0.06$). Perceptions of faculty training adequacy were notably lower (M = 2.8 and 3.1), indicating a shared concern about insufficient professional development, with no significant difference between groups ($p = 0.09$). Chi-square tests further revealed that students at Hanoi National University of Education were more likely to report resource constraints compared to those at the Military University of Culture and Arts ($\chi^2 = 5.12$, $p = 0.02$).

4.2 Qualitative Findings

Thematic analysis of semi-structured interviews with 20 participants (10 students and 10 lecturers/managers) identified three key themes: (1) Benefits of STEAM Integration, (2) Challenges in Implementation, and (3) Role of Digital Transformation.

Benefits of STEAM Integration: Participants highlighted that STEAM fosters interdisciplinary learning, enabling art education students to combine creative expression with technological skills. A student noted, "Using digital tools in STEAM projects helped me create art that feels modern and relevant." Lecturers emphasized that STEAM encourages innovative teaching methods, with one stating, "It allows us to move beyond traditional art lessons and incorporate real-world problem-solving."

Challenges in Implementation: Resource limitations and inadequate faculty training emerged as dominant challenges. Students frequently mentioned outdated technology and limited access to digital platforms, while lecturers expressed concerns about their own readiness to teach STEAM effectively. One manager commented, "We lack the infrastructure and training to fully embrace STEAM in our curriculum."

Role of Digital Transformation: Participants recognized digital tools as critical enablers of STEAM education, with virtual platforms facilitating collaborative projects and creative experimentation. However, they noted barriers such as unreliable internet access and a lack of digital literacy among some faculty. A lecturer remarked, "Digital tools are powerful, but without proper training, they're underutilized."

Table 1. *Participants' Perceptions of STEAM Integration in Art Teacher Education*

Statement	Students (n=150)	Lecturers/Managers (n=45)	p-value (t-test)
STEAM enhances creativity in art education	M = 4.2, SD = 0.7	M = 4.5, SD = 0.6	0.03*
Digital tools improve STEAM teaching effectiveness	M = 4.0, SD = 0.8	M = 4.3, SD = 0.7	0.04*
Lack of resources hinders STEAM implementation	M = 4.1, SD = 0.9	M = 4.4, SD = 0.8	0.06
Faculty training is adequate for STEAM integration	M = 2.8, SD = 1.0	M = 3.1, SD = 0.9	0.09

*Note: *$p < 0.05$ indicates statistical significance.*

4.3 Integrated Findings

Triangulation of quantitative and qualitative data revealed a strong consensus on the potential of

STEAM to enhance art teacher education, particularly through creativity and digital tool integration. However, both groups consistently identified resource constraints and insufficient faculty training as major barriers. These findings underscore the opportunities and challenges of implementing STEAM in Vietnamese pedagogical universities, particularly in the context of digital transformation.

5. Discussion

The findings of this study highlight the transformative potential of STEAM integration in art teacher education within Vietnamese pedagogical universities, aligning with global trends that emphasize interdisciplinary learning and creativity [6]. The quantitative data revealed strong agreement among students and lecturers/managers that STEAM enhances creativity and leverages digital tools to improve teaching effectiveness, corroborating prior research on the value of arts in fostering innovation within STEAM frameworks [2]. However, the statistically significant differences in perceptions between students and lecturers/managers ($p = 0.03$ for creativity, $p = 0.04$ for digital tools) suggest that educators, with their deeper involvement in curriculum design, may recognize STEAM's benefits more readily than students. This discrepancy underscores the need for greater student exposure to practical STEAM applications to align their perceptions with those of educators.

Qualitative insights further enriched the findings, revealing that STEAM's interdisciplinary approach enables art education students to combine creative expression with technological skills, as evidenced by comments about creating "modern and relevant" art. These findings resonate with global studies that highlight STEAM's role in fostering innovative teaching methods [5, 4]. However, the persistent challenges of resource limitations and inadequate faculty training, as identified in both survey data ($M = 4.1$ and 4.4 for resource constraints) and interviews, align with previous research on barriers to STEAM implementation in Vietnam [11, 9]. The lack of statistical significance in perceptions of resource constraints ($p = 0.06$) suggests a shared concern across both groups, reinforcing the urgency of addressing infrastructural deficiencies.

The role of digital transformation emerged as a critical factor, with participants recognizing digital tools as enablers of STEAM education but noting barriers such as unreliable internet and limited digital literacy. These findings echo global studies on the importance of digital competencies in modern teacher training [4] and highlight the need for Vietnamese pedagogical universities to invest in technological infrastructure and faculty development. The low mean scores for faculty training adequacy ($M = 2.8$ and 3.1) indicate a gap in professional development, consistent with Ho and Pham (2022) [13], who emphasize the need for targeted training to enhance STEAM competencies. The chi-square result ($\chi^2 = 5.12$, $p = 0.02$) showing greater resource constraints at Hanoi National University of Education suggests institutional disparities that require tailored policy interventions.

Overall, the findings suggest that while STEAM holds significant promise for innovating art teacher education, its successful implementation in Vietnam depends on overcoming systemic barriers. This requires a multifaceted approach, including curriculum reform, investment in digital infrastructure, and comprehensive faculty training, to align Vietnamese pedagogical universities with global STEAM education standards [12, 7].

6. Conclusion

This study investigated the integration of STEAM in art teacher education within Vietnamese pedagogical universities, focusing on the role of digital transformation. The results confirm that STEAM enhances creativity and teaching effectiveness, offering a pathway to modernize art education in Vietnam. However, significant challenges, including resource limitations and inadequate faculty training, hinder its full implementation. Digital tools are recognized as critical enablers, yet barriers such as unreliable infrastructure and limited digital literacy must be addressed. The study's findings underscore the need for targeted investments in technology, professional development, and curriculum reform to align Vietnamese art teacher education with global standards. By addressing these challenges, pedagogical universities can better prepare art teachers to meet the demands of the digital era, fostering creativity and innovation in their students. Future research should explore longitudinal impacts of STEAM implementation and strategies to scale successful practices across Vietnamese higher education institutions.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could

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