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Development and Implementation of Information Technology-Based Learning Media in Project-Based Animation Learning at State Vocational School 4 Madiun

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Abstract

The transformation of education in the digital era necessitates the integration of information technology into learning processes to enhance the quality and relevance of education, particularly in vocational education. This study aims to analyze the development and implementation of information technology-based instructional media in project-based animation learning at SMK Negeri 4 Madiun. The study employed a qualitative approach using a case study design. Data were collected through observations, in-depth interviews, and documentation and were subsequently analyzed using an interactive analysis model consisting of data reduction, data display, and conclusion drawing. The findings reveal that information technology-based instructional media have been adaptively implemented and effectively integrated with industry demands through the Project-Based Learning (PjBL) model. Digital technologies function as the primary instructional medium throughout the learning process, ranging from concept visualization to animation production, and are supported by project-based assessment involving industry practitioners. The implementation of these technologies has contributed to increased student engagement, creativity, and technical competencies relevant to workplace requirements. However, several challenges were identified, including limitations in facilities and infrastructure, particularly the availability of devices with adequate specifications, as well as constraints related to instructional time and students' digital competencies.

Keywords: information technology, instructional media, Project-Based Learning, animation learning, vocational education, digital transformation.

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INTRODUCTION

The rapid advancement of digital technology has fundamentally transformed educational practices worldwide, making the integration of information technology (IT) into teaching and learning processes no longer optional but essential. The adoption of digital technologies has reshaped learning environments by enabling greater flexibility, interactivity, personalization, and accessibility to diverse educational resources (Dewi, 2024; Jusman & Usman, 2025; Bahani & Kholid, 2024). Various forms of technology-enhanced learning media, including multimedia applications, interactive videos, animation-based content, mobile learning platforms, websites, and augmented reality systems, have demonstrated considerable potential in improving students' motivation, engagement, and academic achievement across different educational levels, ranging from primary schools to higher and vocational education (Karengga & Suti'ah, 2025; Wowor et al., 2025; Aprilianto et al., 2022; Ramadhan et al., 2025; Ulfa & El-Yunusi, 2025; Cipto et al., 2022; Rosinta et al., 2023; Adrianda & Wulandari, 2025). These developments reflect the growing recognition that digital learning media play a strategic role in facilitating meaningful learning experiences and supporting the development of competencies required in the twenty-first century.

Despite these opportunities, the implementation of information technology-based learning media remains uneven and faces numerous challenges. Previous studies have identified several barriers, including inadequate infrastructure, limited availability of digital devices, unequal access to technology, insufficient digital literacy among teachers and students, and the continued dominance of conventional teacher-centered instructional approaches (Karengga & Suti'ah, 2025; Dewi, 2024; Sugiyantoro & Apriliantoni, 2025; Zamani & Suherman, 2022; Jusman & Usman, 2025; Bahani & Kholid, 2024; Adrianda & Wulandari, 2025). As a result, the transformative potential of digital learning media has not been fully realized in many educational settings. This issue is particularly critical in vocational education, where learning activities are expected to simulate authentic workplace practices and foster the development of technical, collaborative, and problem-solving competencies. Digital technologies are increasingly recognized as important tools for supporting project-based learning environments that encourage creativity, collaboration, critical thinking, and digital literacy, all of which are considered essential competencies for the modern workforce (Ripai & Ropiah, 2023; Sugiyantoro & Apriliantoni, 2025; Hanif et al., 2025; Jusman & Usman, 2025; Rani, 2023; Adrianda & Wulandari, 2025). Consequently, there is a growing need to investigate how information technology-based instructional media can be developed and implemented in ways that address existing infrastructural, pedagogical, and technological challenges while simultaneously enhancing learning quality and relevance.

The urgency of this issue becomes particularly evident within the animation sector, which has experienced significant growth in Indonesia in response to increasing demand for digital content across entertainment, education, advertising, and creative industries. The animation and video subsectors have emerged as important contributors to the creative economy, creating substantial demand for graduates equipped with advanced digital competencies and industry-relevant skills. This situation

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requires vocational education institutions, particularly vocational high schools offering animation programs, to align their instructional practices with contemporary industry standards and technological developments. In this context, information technology-based instructional media serve not merely as teaching aids but also as platforms for simulating professional work environments, thereby enabling students to engage in authentic learning experiences that closely resemble real-world industry practices.

However, implementing technology-enhanced learning within animation education presents its own challenges. One of the most significant issues concerns the persistence of the digital divide among students. Not all learners have access to high-performance computers or laptops capable of running professional animation software outside school hours. Variations in access to digital devices and reliable internet connectivity directly influence students' ability to complete animation projects independently and engage in continuous learning beyond the classroom. Consequently, the effectiveness of information technology-based instructional media is determined not only by the quality of the media itself but also by students' access to technological resources and the availability of supportive digital infrastructure. Therefore, the development of instructional media in vocational education must consider issues of accessibility, device efficiency, usability, and flexibility to accommodate the diverse technological conditions experienced by students.

Although numerous studies have reported the positive impact of digital learning media on student motivation, engagement, and academic performance, evidence suggests that their implementation in educational practice remains relatively superficial. In many cases, digital technologies are used primarily as visual presentation tools, such as PowerPoint slides, rather than as interactive learning environments that actively support student-centered learning (Mufida et al., 2025; Manek & Butarbutar, 2024; Ulfa & El-Yunusi, 2025; Tasmayanti et al., 2025). Such practices fail to fully leverage the capabilities of digital technologies to facilitate collaboration, problem-solving, authentic learning experiences, and higher-order thinking skills. This limitation is particularly problematic in vocational fields such as animation, where students are expected to develop professional competencies through practical, project-based experiences that mirror industry workflows and standards (Sujarno et al., 2025; Permana et al., 2024; Susanti et al., 2024; Oktaria et al., 2025).

Furthermore, the availability of instructional media capable of integrating multimedia elements, animation, simulation, and industry-based learning experiences remains limited. Existing studies indicate that these limitations are often associated with inadequate infrastructure and teachers' insufficient competencies in designing and developing digital learning media independently (Mufida et al., 2025; Ulfa & El-Yunusi, 2025; Rizal et al., 2023; Tasmayanti et al., 2025; Safitri et al., 2025). As a consequence, learning experiences frequently lack meaningful connections to workplace realities, reducing the relevance of vocational education and potentially limiting graduates' readiness to enter technology-driven professions (Permana et al., 2024; Susanti et al., 2024; Paulana & Kanus, 2025).

Based on these considerations, a significant research gap remains regarding how information technology-based instructional media can be effectively developed and implemented to support project-

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based animation learning while simultaneously addressing issues of accessibility, digital competence, and industry relevance. Much of the existing literature focuses on the effectiveness of specific digital tools or multimedia products, whereas relatively few studies have examined how technology-based instructional media are integrated into vocational learning environments characterized by authentic project work, industry collaboration, and workforce-oriented competency development. Therefore, this study seeks to analyze the development and implementation of information technology-based instructional media in project-based animation learning within a vocational high school context. The findings are expected to contribute both theoretically and practically to the growing body of knowledge on educational technology and vocational education by providing insights into how digital instructional media can support industry-oriented learning, enhance student engagement, and strengthen the alignment between vocational education and the demands of the digital economy.

METHODS

This research employed a qualitative approach with a case study design, aiming to gain an in-depth understanding of the implementation of information technology-based learning media in a real-life learning context. The research location was determined to be SMK Negeri 4 Madiun, considering that the school has implemented technology-based learning, particularly in the field of animation. This research received institutional approval from the school as the research location. The entire data collection process was conducted with due regard for assessment ethics, including participant consent, data confidentiality, and the use of information for academic purposes only. The research subjects consisted of subject teachers, students, and relevant parties directly involved in the learning process. Subjects were selected using purposive sampling based on their involvement and relevance to the research focus. The number of subjects was adjusted to meet data needs until data saturation was reached, ensuring that the information obtained was deemed sufficiently representative to describe the phenomenon under study.

Data collection techniques included observation, in-depth interviews, and documentation to obtain comprehensive data. The research instruments included observation guidelines to observe the learning process, semi-structured interview guidelines to gather information from the research subjects, and documentation sheets to collect supporting data, such as teaching modules and learning media used. Semi-structured interviews were conducted with teachers, students, and industry partners using interview guidelines developed based on the research focus. Questions to teachers focused on the process of developing information technology-based learning media, project-based learning implementation strategies, and challenges in using animation devices and software. Questions to students focused on their learning experiences using digital media, their involvement in animation projects, and any barriers to technology access they encountered. Meanwhile, questions to industry partners covered the relevance of learning media and projects to the needs of the animation industry, expected competency standards, the effectiveness of project-based evaluations, and the forms of feedback provided to students during the learning process.

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To ensure the objectivity of industry evaluations, assessments were conducted using competency indicators mutually agreed upon by teachers and industry partners, encompassing creativity, animation techniques, project completion, and compliance with industry production standards. Furthermore, industry evaluation results were compared with observations and documentation of student projects through data triangulation techniques, ensuring that the assessments were not merely formalistic but rather reflected students' actual competency achievements. Data analysis was conducted using interactive analysis techniques, including data reduction, data presentation, and conclusion drawing/verification. To ensure the validity of the data, this study applies source and method triangulation techniques so that the research results have a high level of credibility and validity.

RESULTS

This study was conducted at SMK Negeri 4 Madiun, a vocational secondary school that emphasizes the development of industry-oriented competencies through technology-enhanced learning environments. The research focused on the Animation program, which aims to equip students with both technical and creative competencies in two-dimensional (2D) and three-dimensional (3D) animation production. Learning activities within the program are designed around practical and project-based experiences, allowing students to engage actively in the complete animation production cycle, including conceptualization, design, production, and evaluation. Digital technologies serve as the primary learning medium throughout this process, reflecting the industry's increasing reliance on technology-driven creative production workflows.

The findings indicate that instructional planning within the Animation program is systematically developed through curriculum alignment with both national educational standards and industry requirements. Curriculum synchronization activities involving industry partners are conducted regularly to ensure that learning materials, technical competencies, and project outcomes remain relevant to current professional practices. As a result, learning objectives are formulated not only to develop students' conceptual understanding but also to strengthen technical expertise, creativity, collaboration, and professional attitudes required in the animation industry. This alignment demonstrates a deliberate effort to reduce the gap between vocational education and labor market expectations while preparing students for future employment opportunities within the creative sector.

The primary instructional strategy implemented in the Animation program is Project-Based Learning (PjBL). This approach positions students as active participants who construct knowledge through authentic project experiences closely related to professional animation production. Learning activities are organized sequentially, beginning with concept development and storyboard planning, followed by design creation, animation production, and final project presentation. Through this process, students are encouraged not only to acquire theoretical knowledge but also to apply that knowledge in realistic production contexts. Teachers function primarily as facilitators and mentors, guiding students throughout project implementation, monitoring progress, and providing continuous feedback. Consequently, classroom interactions are characterized by a more participatory learning

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environment in which students are expected to demonstrate initiative, creativity, technical proficiency, and collaborative problem-solving skills.

An important finding emerging from this study is the existence of a feedback-loop mechanism involving students, teachers, and industry mentors throughout the animation production process. Students receive iterative feedback during multiple stages of project development, including concept refinement, storyboard evaluation, design revision, animation production, and final product assessment. Feedback is delivered through both face-to-face consultation sessions and digital communication platforms integrated into the learning process. This continuous cycle of revision and improvement closely resembles professional industry practices, where creative products undergo multiple rounds of evaluation before reaching final approval. As a result, students experience a learning environment that extends beyond conventional classroom instruction and more closely reflects authentic workplace conditions.

These findings demonstrate a strong connection with the Teaching Factory (TeFa) approach that has been widely promoted in Indonesian vocational education. However, the present study highlights a distinctive characteristic whereby information technology-based instructional media function not only as production tools but also as collaborative learning spaces that facilitate interaction among students, teachers, and industry practitioners. This collaborative ecosystem enables students to engage in authentic learning experiences while receiving direct exposure to professional standards and industry expectations. Therefore, the integration of digital media within animation learning represents a more interactive and adaptive model of vocational education that responds effectively to the evolving demands of the digital creative industry.

The implementation of technology-enhanced learning in the Animation program relies heavily on the use of professional software applications and digital production tools commonly utilized within the animation industry. These technologies support various instructional activities, ranging from concept visualization and digital illustration to animation production and post-production processes. Unlike conventional instructional media that merely support content delivery, technology in this context becomes an integral component of the learning process itself. Students interact directly with industry-standard tools throughout every stage of project development, allowing them to gain practical experience while simultaneously developing workplace-relevant competencies. This finding reinforces the notion that technology integration in vocational education should extend beyond content presentation and focus on creating authentic learning environments that mirror professional practice.

Assessment within the Animation program is conducted through project-based evaluation mechanisms that emphasize both learning processes and final products. Students' performance is assessed based on project quality, technical execution, creativity, problem-solving abilities, and adherence to professional production standards. Importantly, industry representatives are involved in the evaluation process, providing external perspectives that increase the authenticity and relevance of assessment practices. Evaluation activities are conducted progressively throughout project

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implementation rather than solely at the completion stage, enabling students to receive formative feedback and continuously improve their work. Such assessment practices contribute to a more comprehensive understanding of students' competencies and better reflect the performance expectations of the creative industry. Despite these positive practices, several challenges continue to affect the implementation of information technology-based learning within the Animation program. The most significant challenge concerns the limited availability of high-specification hardware required to operate professional animation software efficiently. Given the computational demands associated with animation production, particularly during rendering and post-production stages, available devices are often insufficient to accommodate all students simultaneously. Consequently, students must share laboratory facilities and utilize equipment on a rotational basis, which can reduce learning flexibility and limit opportunities for extended practice.

In addition to infrastructure-related constraints, several non-technical challenges were identified. Differences in students' technological proficiency, varying levels of digital literacy, and limited instructional time influence the effectiveness of project implementation. Some students require additional support to master complex software applications and digital production workflows, creating disparities in project completion rates and learning outcomes. These findings suggest that successful technology integration depends not only on technological resources but also on learners' readiness and the availability of adequate instructional support.

To address these challenges, both teachers and school administrators have implemented a range of adaptive strategies. Teachers modify instructional approaches by providing intensive guidance, differentiated support, and flexible project management practices. One notable strategy involves prioritizing the use of high-performance devices for rendering and final production tasks while utilizing lower-specification devices for storyboard development, concept design, and basic animation exercises. Teachers also employ low-resolution proxy workflows during early production stages to reduce computational demands and optimize available resources. Meanwhile, the school supports implementation through laboratory management systems, rotational scheduling, and infrastructure allocation designed to ensure equitable access to technological resources. These adaptive measures illustrate how vocational institutions can strategically respond to resource limitations while maintaining the quality and continuity of technology-enhanced learning.

Overall, the findings suggest that information technology-based instructional media have been successfully integrated into project-based animation learning and have contributed significantly to creating industry-relevant learning experiences. Nevertheless, the sustainability and effectiveness of such initiatives remain closely linked to infrastructure availability, students' digital readiness, and institutional capacity to support technology-enhanced vocational education. The results further indicate that successful digital transformation in vocational schools requires not only technological investment but also pedagogical innovation and sustained collaboration between educational institutions and industry stakeholders.

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DISCUSSION

The findings of this study demonstrate that the implementation of animation learning at SMK Negeri 4 Madiun has successfully integrated information technology-based instructional media in a contextual, practical, and industry-oriented manner. This integration is reflected in the extensive use of animation software, digital production tools, computer laboratories, and project-based learning activities that enable students to engage directly with digital technologies throughout the learning process. Within this environment, technology serves not merely as a supplementary instructional aid but as a core component of learning that facilitates the development of technical competencies, creative abilities, and professional skills required in the animation industry. The integration of digital media into instructional activities aligns with the broader objective of vocational education, which seeks to bridge the gap between school-based learning and workplace requirements through authentic learning experiences.

The study further reveals that curriculum implementation within the Animation program is characterized by a strong alignment with industry needs. Curriculum synchronization activities involving industry stakeholders ensure that learning content, project assignments, and competency standards remain relevant to current developments in the digital creative sector. This adaptive curriculum approach allows students to select specialization pathways, including two-dimensional (2D) and three-dimensional (3D) animation, while utilizing digital learning media tailored to their interests and professional aspirations. Such flexibility reflects the growing importance of differentiated learning in vocational education, where instructional strategies are designed to accommodate diverse student talents, learning preferences, and career trajectories. Consequently, information technology functions not only as a delivery medium but also as a mechanism for supporting personalized and competency-based learning experiences.

Another significant finding concerns the role of industry involvement in the assessment process. The participation of industry practitioners in evaluating student projects enhances the authenticity and relevance of learning outcomes by exposing students to professional standards and expectations. Project-based digital assessments encourage learners to produce tangible outputs that mirror real-world industry products, thereby strengthening the connection between educational experiences and workplace demands. Through this process, students receive constructive feedback that extends beyond academic criteria and incorporates professional considerations related to creativity, technical quality, workflow management, and client-oriented production standards. As a result, learning outcomes become more meaningful and contribute directly to students' career readiness within the creative industry sector.

These findings are consistent with constructivist learning theory, which emphasizes that knowledge is actively constructed through meaningful experiences and interactions with authentic tasks. The implementation of Project-Based Learning (PBL) supported by digital technologies provides opportunities for students to learn through exploration, experimentation, collaboration, and reflection.

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Rather than passively receiving information, students actively participate in solving problems, creating digital products, and making decisions throughout the animation production process. In this regard, technology serves as a facilitator that supports student-centered learning environments and promotes deeper engagement with learning content. The findings therefore reinforce the argument that effective technology integration should focus on transforming learning experiences rather than merely digitizing traditional instructional practices.

Classroom observations further indicate that project-based learning supported by animation software and digital media contributes to the development of higher-order thinking skills. Students are required to analyze project requirements, identify appropriate design solutions, manage production workflows, and evaluate the effectiveness of their final products. These activities encourage critical thinking, creativity, problem-solving, and decision-making skills, all of which are recognized as essential competencies for the twenty-first-century workforce. The use of digital production tools also facilitates experiential learning by allowing students to visualize abstract concepts and transform creative ideas into concrete outputs. Consequently, technology-enhanced learning environments provide a valuable platform for fostering both technical proficiency and cognitive development among vocational students.

The findings additionally suggest that information technology-based instructional media possess considerable flexibility and adaptability in supporting animation education. Various digital applications can be utilized according to learning objectives, available resources, and student needs. The growing availability of animation platforms and digital content creation tools offers opportunities for educators to design innovative learning experiences that are both engaging and industry-relevant. This flexibility is particularly important in vocational education, where rapid technological change requires continuous adaptation of instructional practices and learning resources. Therefore, the successful integration of technology in animation learning should be viewed as an ongoing process of innovation rather than a one-time implementation effort.

From a practical perspective, the study highlights several important implications for vocational education institutions. First, information technology should be positioned as a central element of instructional design rather than as an auxiliary teaching tool. Effective implementation requires teachers to possess adequate digital competencies that enable them to select, develop, and manage technology-enhanced learning experiences. Consequently, continuous professional development programs are necessary to strengthen teachers' technological, pedagogical, and content knowledge. Second, educational institutions must invest in infrastructure capable of supporting increasingly sophisticated digital learning environments. The availability of high-performance computers, licensed software applications, stable internet connectivity, and well-equipped laboratories remains a critical factor in ensuring successful implementation of technology-based instruction.

The study also underscores the strategic importance of collaboration between schools and industry partners. Industry involvement not only enhances curriculum relevance but also contributes

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to more authentic learning experiences and assessment practices. Through collaborative partnerships, students gain exposure to current industry standards, professional workflows, and emerging technological developments, thereby reducing the gap between educational preparation and labor market demands. This model may serve as a best-practice framework for strengthening vocational education systems and improving graduate employability within the rapidly evolving digital economy.

Despite these positive findings, several limitations remain. The most prominent challenge relates to infrastructure constraints, particularly the limited availability of high-specification hardware required for animation production activities. Devices with sufficient processing power and memory capacity remain essential for operating professional animation software efficiently. As a result, students often share laboratory facilities and access equipment on a rotational basis, limiting opportunities for extended hands-on practice. Such constraints may affect both learning efficiency and the quality of project outcomes, particularly during computationally intensive stages such as rendering and post-production.

Furthermore, the study was conducted within a single institutional context using qualitative methods, including observations and interviews. While this approach provided rich and contextualized insights into the implementation of information technology-based learning media, the findings cannot be generalized to all vocational schools. Variations in institutional resources, technological infrastructure, teacher competencies, and student characteristics across different regions may lead to different implementation experiences and outcomes. Future studies are therefore encouraged to employ broader research designs involving multiple institutions and larger participant groups. Mixed-methods or comparative studies could provide more comprehensive evidence regarding the effectiveness, scalability, and sustainability of technology-enhanced learning practices in vocational education. Such investigations would contribute to a deeper understanding of how digital transformation can be effectively implemented across diverse educational settings while maintaining alignment with industry needs and workforce development objectives.

CONCLUSIONS

Based on the research findings, it can be concluded that the implementation of information technology-based learning media in the Animation expertise program at State Vocational High School 4 Madiun demonstrates that the transformation of vocational learning in the digital era depends not only on the use of technology but also on the integration of the curriculum, digital media, and industry needs. Project-based learning supported by information technology media can create a more contextual, collaborative learning environment that resembles real-world industrial work practices through the involvement of industry mentors and a continuous feedback loop.

This research resulted in the concept of the Industry-Integrated Media model, a vocational learning model that integrates digital media, industry evaluation, and a Project-Based Learning approach within a single adaptive learning system. This model enables students to gain more authentic learning experiences while enhancing their job readiness in the digital creative industry. The research

findings also demonstrate that limited resources are not always a major obstacle if schools are able to implement adaptive strategies in managing learning devices and media. Broadly speaking, the results of this study have implications for the development of vocational education in Indonesia, particularly in the technology-based creative industry. Vocational schools need to develop a Curriculum-Media Synchronization framework, which involves continuous synchronization between the curriculum, learning media, and developments in software and industrial technology. With this approach, learning media will not only meet current learning needs but also be able to evolve in line with future technological changes and digital industry standards.

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I.Q.A.: Writing – Original Draft Preparation, Data Curation
N.L.R.: Writing – Review & Editing
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A.S.: Writing – Review & Editing
F.R.: Writing Final Draft, Review & Editing
M.A.B.: Writing – Review & Editing

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