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Bridging Vocation 4.0 Readiness: Needs Assessment of Interactive Simulation Media in Manufacturing-Focused Vocational High Schools

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Abstract

Digital transformation is essential for Vocational Education (SMK) to produce competitive graduates in the Industry 4.0 era, but there is a significant gap between the demands for practical skills and the dominant static teaching practices. This study aims to analyze the specific needs of digital learning media in Magetan Vocational High Schools (SMK) based on teacher and student perceptions. This study adopted a descriptive mixed-methods approach with a convergent triangulation design, chosen to validate and elaborate quantitative findings (student perceptions) with qualitative data (teacher context and barriers) in depth. Data were collected through a TPACK-based Media Needs Questionnaire (N=43 students) analyzed with percentages and averages, as well as semi-structured interviews (N=3 teachers) and observations of the learning environment, which were analyzed thematically. The results showed a sharp discrepancy: static media (PDF/PowerPoint) were rated the least effective (23.3%), while students collectively highly demanded Interactive Simulations/Virtual Laboratories (88.4%) and Project-Based Video Tutorials (81.4%). The implementation of these demands is hampered by systemic factors, particularly unstable infrastructure (internet/hardware), uneven distribution of teachers' pedagogical-technological competencies, and limited time for media development. This study concludes that the primary output of the needs analysis is the need to develop interactive simulation media oriented toward vocational practice. These findings provide an empirical basis for strategic policy revisions that focus on improving digital infrastructure and targeted teacher competency training to ensure effective and sustainable media adoption.

Keywords: Digital Media Needs, Vocational Education, Interactive Simulation, Teacher Competence, SDGs 4.

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INTRODUCTION

Digital transformation in vocational education in the Industry 4.0 era is crucial, especially amidst technological developments that impact various aspects of life, including education. Digitalization provides opportunities for vocational education institutions to update teaching methods, improve curriculum effectiveness, and prepare students for an increasingly competitive job market (Xu et al., 2024). Research shows that the integration of appropriate digital learning tools and methods can improve educational quality, provide insights into industry developments, and encourage innovation in how students learn and interact with course materials (Yao & Shi, 2024). Therefore, adapting to digital technology is not only a necessity but also a way to optimize educational outcomes, ensuring that students are prepared to face the challenges of the ever-changing world of work.

Digital learning media plays a significant role in improving the quality of learning in Vocational High Schools (SMK). Related reports have shown that the use of digital media, such as Quizizz and online projects (Surya & Sutopo, 2024), has increased student motivation and engagement. Through such media, students can gain better access to information, collaborate on projects, and apply practical skills through simulations (Kalapati et al., 2024). Research shows that developing interactive digital learning media can accelerate students' understanding of the material and improve their skills, thus creating a more engaging and effective learning environment (Wijaya et al., 2024). Therefore, integrating digital learning media into educational activities at vocational schools is crucial for producing qualified graduates who are ready to contribute to the industry.

In most vocational high schools (SMK) in the Magetan region, the challenges of modernizing vocational education are palpable, particularly in terms of Information and Communication Technology (ICT) gaps. Although some leading schools have established high-quality computer labs, the majority still struggle with limited hardware and uneven internet connections. Teacher readiness is another crucial factor, with independent teacher initiative in adopting digital platforms and blended learning crucial. Structured training from government agencies is often limited, creating a disparity between young, adaptable teachers and senior teachers who are still comfortable with conventional methods. At the school policy level, although the majority of vocational high schools have integrated the Merdeka Belajar program and promoted the Merdeka Curriculum, full implementation is often hampered by tight budgetary bureaucracy and slow updates to practical facilities. Therefore, the goal of producing work-ready graduates with superior digital competencies still requires accelerated investment, both from local governments and in collaboration with local industry.

Digital learning media in the modern education era is defined as technology-based tools that deliver information interactively and engagingly to students (Sugitra et al., 2022). These types include interactive multimedia, e-learning, and internet-based and mobile applications. Their key characteristics—interactivity, flexibility, and the ability to accommodate various learning styles—have been shown to increase motivation and participation (Shefira et al., 2024) and support the development

of students' critical and analytical skills (Triani & Pratiwi, 2023). Proper implementation creates a more inclusive learning environment, allowing students to learn at their own pace.

However, to ensure the maximum effectiveness of these digital learning media, a crucial step in their development is conducting a needs analysis. This analysis serves to identify the specific needs of users (teachers and students), ensuring that the designed media is relevant and effective (Buchori, 2019). The process includes collecting data on backgrounds, preferences, and challenges of conventional learning (Costa et al., 2023). Research shows that media designed based on in-depth analysis tend to be more accepted and implemented effectively in the classroom (Aprianty et al., 2021). In fact, needs analysis yields strong evidence for this approach: Sugitra (2021) found that needs analysis helps identify specific challenges such as low student motivation and complex learning materials, while Salshabella et al. (2022) showed that it revealed students' desires for flexible and independently accessible learning media. Consistently, research across various vocational high school subjects confirms that systematic needs analysis leads to more targeted media development. Thus, needs analysis not only helps create effective media but also serves as a systematic and critical approach to ensure that digital learning media truly enhances students' understanding and skills, particularly in vocational education (Afriliana & Diyana, 2024).

While numerous studies demonstrate the general effectiveness of digital media (Wijaya et al., 2024; Maswati & Faridah, 2022), and studies generally emphasize the need for needs analysis (Tambunan, 2021), significant empirical gaps exist at the local level. Specifically, there is a lack of detailed and specific empirical data regarding digital media needs in vocational high schools (SMK) in Magetan, despite the factual conditions in the region demonstrating significant disparities. As previously identified, vocational high schools in Magetan still struggle with limited hardware and uneven teacher preparedness, in addition to budgetary bureaucracy that hinders the renewal of practical facilities. This gap indicates that many learning media development efforts are conducted without a basis in the real needs of teachers and students in Magetan. This potentially leads to poor implementation and a mismatch between the developed media and the unique challenges and preferences of local users.

Therefore, this needs analysis research is expected to provide dual and strategic benefits. First, it will provide a strong empirical basis for the development of digital learning media in vocational high schools in the Magetan region, ensuring that any investment in media development is oriented towards solving real problems, such as low motivation or material complexity (Tambunan, 2021). Second, the results of this analysis will serve as important considerations for school policies and technology-based teacher training programs. Data on ICT readiness, teacher and student preferences, and the types of media most needed can be used by education offices and schools to plan budget allocations, accelerate the renewal of practical facilities, and design more targeted training to enable teachers to effectively adopt digital platforms, thereby achieving the goal of producing graduates with superior digital skills. Considering that digital transformation in vocational education is an essential need in the Industry 4.0



era (Xu et al., 2024), and it is proven that digital learning media plays a significant role in increasing student motivation and engagement in vocational schools (Hamdan, 2024; Surya & Sutopo, 2024), this study aims to analyze the need for digital learning media in vocational schools in the Magetan region based on teacher and student perceptions. This analysis focuses on identifying student learning preferences, challenges faced by teachers in teaching, and the gap between available ICT facilities and the demands of the modern curriculum.

METHODS

This study adopted a mixed-methods descriptive approach with a Concurrent Triangulation Design (Creswell, 2014). This design was chosen to obtain a comprehensive understanding by collecting quantitative and qualitative data simultaneously, and converging their interpretations to validate media needs and interpret implementation barriers. The research subjects consisted of two groups: quantitative data were collected from 43 Magetan vocational high school students through convenience sampling using the TPACK-based Media Needs Questionnaire, the results of which were analyzed using percentages and average scores. Meanwhile, qualitative data were collected from 3 vocational high school teachers through semi-structured interviews and observations, which were analyzed thematically. These three teachers were selected purposively (purposive sampling) as productive teachers representing diverse fields of expertise, namely Visual Communication Design (DKV), Computer and Network Engineering (TKJ), and Online Business and Marketing (BDP). This diversity ensures the external validity of the qualitative findings regarding media implementation barriers across various vocational contexts in Magetan. Triangulation of findings was carried out at the final stage to compare media demands by students with implementation capacity by teachers.

RESULTS

Current Availability and Utilization of Digital Learning Media

Direct observations of learning in three different classrooms and a review of the ICT learning environment (Computer Laboratory) confirmed a significant gap between the availability of resources and their pedagogical use.

Physically, basic infrastructure such as LCD projectors and computer laboratories are available at the schools subject to the study. However, their use in daily teaching practices remains very limited and tends to be passive. Classroom observations revealed that LCD projectors primarily serve as a substitute for whiteboards, primarily for displaying text-heavy PowerPoint presentations (a one-way transfer of information) or playing YouTube videos without accompanying interactive activity guides. This pattern suggests that technology adoption is still at the substitution stage, not yet transforming or redefining the learning process. The most dominant digital learning medium found is the distribution of static materials (PDFs, e-books, or MS Word summaries) shared through messaging platforms (WhatsApp Groups). During the observations, students were observed spending more time looking at their personal device screens to read these materials, a process that is essentially a digitization of conventional textbooks and lacks interactivity.



Furthermore, these observations validated the factual conditions previously identified in Magetan: unstable internet connections outside the laboratory area were a major barrier. During one observation session, a teacher (T1) attempted to demonstrate a vocational simulation portal, but experienced long buffering times, ultimately forcing the teacher to revert to conventional methods (drawing diagrams on the whiteboard) for the sake of time efficiency. Utilization of the computer laboratory also focused on the use of generic applications (word processing), rather than on simulation software or specific vocational applications that should be at the core of vocational learning. In short, field observations concluded that the digital media currently used remains static, passive, and highly dependent on individual teacher initiative in overcoming real infrastructure barriers.

Digital Learning Media Needs Analysis

A needs analysis administered to 43 student respondents (N=43) provided a clear quantitative picture of the discrepancy between the media they currently receive (as identified in observations) and the media they consider most essential for vocational learning. Key findings indicate that students collectively reject static media and demand media that focus on interactivity, process visualization, and practical application. Cross-tabulation results from the needs questionnaire revealed the following specific preferences.

Table 1. Student Questionnaire Analysis

Types of Digital Learning Media	Percentage of Needs (N=43)	Interpretation of Field Findings
Interactive Simulations/Virtual Laboratories	88.4% (38 students)	This is the highest need. In the vocational high school context, students don't just want to "learn about" a machine or procedure; they want to "try it out." This need reflects a desire for psychomotor practice or problem-solving (e.g., troubleshooting a virtual network) that isn't bound by the limitations of physical tools in a workshop.
Project-Based Video Tutorials (Vocational Specific)	81.4% (35 students)	Students don't want lengthy conceptual videos. This preference refers to concise, step-by-step video tutorials for completing specific tasks (e.g., "How to Configure a Router" or "Welding XYZ Steps"). This encourages self-paced learning and repetition of difficult material.
Mobile Learning Applications (m-learning)	76.7% (33 students)	This finding is highly relevant to the observed infrastructure conditions. Students are aware of the instability of the school's Wi-Fi and limited access to the Computer Lab. They rely more on personal devices and their own data plans. The need for mobile learning reflects a demand for flexibility and accessibility outside of school hours.
Interactive Quizzes and Gamification	65.1% (28 students)	This need demonstrates students' desire to shift from stressful summative assessments to instant and engaging formative feedback. They want to test their understanding in low-stakes (without high stakes) games.



Static Digital Modules (E-books/PDF Materials)	23.3% (10 students)	This percentage is a key finding. The media currently most commonly used (such as observational findings) are actually the least desirable among students. They consider them passive, boring, and ineffective for understanding complex vocational material.
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Tabel 2. Digital Learning Media Needs Analysis

No.	Types of Digital Learning Media	Level of Need (%)	Effectiveness Level (Currently Used) (%)
1	Interactive Simulations / Virtual Laboratories	88,4	37,2
2	Project-Based Video Tutorials	81,4	60,5
3	Mobile Learning (m-learning)	76,7	51,2
4	Educational Games	69,8	27,9
5	Interactive E-Modules	67,4	48,8
6	Static Presentations (PPT/PDF)	48,8	23,3

Table 2 shows a significant discrepancy between student needs and the effectiveness of currently dominant media. Students demonstrated the highest demand for practical and interactive media, with Interactive Simulations/Virtual Laboratories topping the list (88.4%). Further high demand was demonstrated for Project-Based Video Tutorials (81.4%) and Mobile Learning (76.7%). Furthermore, the most frequently used media, Static Presentations (PPT/PDF), was rated the least effective by students (only 23.3% deemed effective), demonstrating the failure of static media to facilitate vocational learning focused on psychomotor skills. These findings strongly justify the need for media development to focus on interactive and simulation-based solutions.

Overall, these quantitative student data send a strong signal: the digital learning media needed at Magetan Vocational High Schools must shift from the paradigm of "digital reading materials" to "digital practice tools," which aligns with Salshabella et al.'s (2022) demand for flexible and independently accessible media.

Factors Inhibiting the Use of Digital Media

To complement the quantitative data from students, semi-structured interviews were conducted with three teachers (T1, T2, T3) to explore their perceptions of the main barriers to digital media implementation. Thematic analysis of the interview transcripts revealed that these barriers are complex and interconnected, encompassing aspects of infrastructure, competency, and school policies.

Teacher 1 (T1 - Adaptive/Young): This teacher demonstrated the highest enthusiasm for technology and had tried several platforms (as seen in observations). However, she explicitly stated that her biggest barrier was workload (WKT). "Creating one interactive simulation can take weeks, sir. We don't have the time allocated for that outside of teaching and administrative hours," she said. She was also frustrated with infrastructure (INF): "I've prepared online media, but if the internet is intermittent in class, the students get distracted, so I end up going back to PowerPoint." Teacher 2 (T2 - Senior/Pragmatic): This teacher represents a more cautious group of teachers. Her main barrier is competency and training (KOM). "The training we received was only basic MS Office or Zoom. We were



never trained to create interactive vocational media. I was afraid of making mistakes, or the software being too complicated," he said. He also highlighted student preparedness (SIS): "Students now, when they hold a cell phone, are easily distracted by games or social media, not the material."

Teacher 3 (T3 - Head of Program/Senior): This teacher saw the problem from a more systemic perspective. He highlighted the lack of standardization (STD) and school policy support (INF). "Schools should have an integrated platform, for example, an LMS (Learning Management System). Everything works independently," he said. He also criticized the budget allocation: "We ask for bandwidth upgrades (INF) or simulation software (INF/STD), but the process is bureaucratic and time-consuming. So we just use what's available, which is free, even though it's not optimal."

Thematic analysis of the three interviews identified five main inhibiting themes, summarized in the following frequency table.

Table 3. Interview Findings Analysis

Theme Code	Inhibitor Theme	T1	T2	T3	Key Descriptions (Based on Interview Context)
INF	Infrastructure and Facilities	✓		✓	Unstable internet connection, low student/teacher computer specifications, lack of licensed software.
KOM	Competence and Training	✓	✓		Lack of pedagogical-technological training (not just basic technical training), fear of software complexity.
WKT	Time and Workload	✓		✓	No dedicated time allocated for media development outside of teaching and administrative workload.
STD	Standardization & Policies			✓	No integrated school platform/LMS, no budget policy supporting media innovation.
SIS	Student Readiness		✓		Teachers' perception that students are easily distracted when using personal devices for learning.

The findings of these interviews clearly demonstrate that the problem of digital media implementation at SMK Magetan is not simply a lack of teacher commitment. It is a systemic problem rooted in inadequate infrastructure (INF), a lack of relevant competency development (KOM), and the absence of supportive school policies (WKT/STD), fully confirming the factual conditions identified previously.

DISCUSSION

Digital transformation in vocational education in the Industry 4.0 era is a crucial aspect to consider because technological developments have impacted various dimensions of life, including education. The integration of digital technology into learning has been proven to improve the quality of the educational process, strengthen the effectiveness of the curriculum, and prepare students for an increasingly competitive job market (Xu et al., 2024; Yao & Shi, 2024). Therefore, digitalization is not merely seen as a modernization trend, but as an essential strategy to ensure graduates possess competencies relevant to industry needs.

Digital learning media plays a strategic role in improving the quality of learning in Vocational High Schools (SMK). Previous research has shown that the use of digital platforms and project-based learning models can increase student motivation and engagement (Surya & Sutopo, 2024; Kalapati et



al., 2024; Wijaya et al., 2024). However, in areas like Magetan, the gap between vocational curriculum design and classroom learning practices remains apparent. Many students lack adequate digital practical experience, even though these competencies are a crucial indicator of job readiness in the modern industrial sector.

This situation is exacerbated by real challenges in most vocational schools (SMK) in Magetan, such as unequal access to ICT and limited supporting infrastructure. Although some schools have computer labs, their utilization is not optimal for simulation-based learning or digital practice. In the context of industry needs, this situation impacts students' weak practical digital competencies for example, the ability to use simulation software, technical applications, or digital analysis tools, which contributes to the low absorption rate of graduates into the workforce. At the same time, budget bureaucracy and minimal updates to practical facilities have widened the quality gap between schools.

Digital learning media in the modern era is defined as technology-based tools with interactive, flexible characteristics and the ability to accommodate various learning styles (Sugitra et al., 2022; Shefira et al., 2024; Triani & Pratiwi, 2023). However, these ideal characteristics have not been fully realized in learning practices at vocational schools in Magetan, which are still dominated by the use of static media. This situation demonstrates that the quality of digital media implementation is determined not only by the availability of devices, but also by the teacher's ability to integrate media pedagogically.

To bridge this gap, a needs analysis is necessary as a first step in determining relevant and effective learning media (Buchori, 2019; Costa et al., 2023; Aprianty et al., 2021; Tambunan, 2021; Salshabella et al., 2022; Afriliana & Diyana, 2024). A needs analysis allows for a comprehensive mapping of student preferences and the challenges faced by teachers. In the Magetan context, this analysis is crucial because it can identify specific needs such as a lack of interactive media, digital competency gaps, and infrastructure barriers. Thus, the media developed will be more contextual and appropriate to field conditions.

The theoretical framework on technology adoption provides an important foundation for understanding how learning media can be integrated in the context of vocational schools. Based on the Diffusion of Innovation (DOI) theory, successful media adoption is influenced by user perceptions of the relative advantages, suitability, and complexity of the innovation. In Magetan vocational schools, teachers often perceive interactive media as highly complex or incompatible with existing infrastructure. Furthermore, the TPACK framework is relevant in explaining that effective technology integration requires a balance between technological, pedagogical, and content knowledge. Findings in Magetan indicate that teachers' TK and TPK are still low, hindering the optimal use of digital media.

Although numerous studies have highlighted the effectiveness of digital media and the importance of needs analysis (Wijaya et al., 2024; Maswati & Faridah, 2022; Tambunan, 2021), empirical gaps remain in local contexts like Magetan. The lack of specific data on digital media needs in



vocational schools in this region has resulted in many media development efforts not being based on real-world problems. Therefore, the needs analysis in this study has strategic value in ensuring that digital media development addresses fundamental issues, such as low learning motivation, lack of access to practical simulations, and limited pedagogical-technological competencies in teachers.

This study also has limitations, primarily due to its limited scope, which was limited to a few vocational high schools (SMK) in the Magetan region and involved a relatively small number of respondents. These limitations impact the generalizability of the findings. Nevertheless, the results of this study open up prospective research directions, particularly the development of digital learning media based on student and teacher needs, such as interactive simulation prototypes or project-based videos, as well as further research related to media effectiveness and teacher training. Based on this urgency, this study aims to analyze the need for digital learning media in vocational high schools in the Magetan region based on teacher and student perceptions, as a first step in improving the quality of vocational learning.

CONCLUSIONS

The conclusions of this needs analysis indicate that there is a significant discrepancy between the digital learning media currently used in SMK Magetan (which tend to be static and passive) and the real needs of students, who demand highly interactive and practical media, such as virtual simulations and project-based video tutorials (88.4%). Students' readiness to integrate digital media is high, as evidenced by their demand for the flexibility of m-learning; however, teachers' readiness to develop and implement it is hampered by crucial systemic factors, primarily the instability of ICT infrastructure, the lack of relevant competency training, and workloads that leave little time for innovation. Based on these findings, this study recommends strategic advice: For schools and policymakers, the focus should be directed at providing stable ICT facilities (especially internet connections) and establishing supporting policies that allocate specific time and budget for training in the development of interactive vocational media. Meanwhile, for future researchers, it is recommended to use the quantitative and qualitative data from this needs analysis as an empirical basis for immediately developing learning media prototypes (e.g., simulation applications or mobile project videos) that directly address the specific needs of SMK Magetan students.

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