

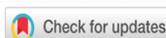
Integrating Vocationality-Based Web Media with Blended Learning for Enhancing Practical Competence in Vocational Education

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ABSTRACT

Objective: Vocational education requires learning media that not only support the delivery of conceptual knowledge but also facilitate hands-on practice relevant to workplace demands. **Method :** This study aims to develop and evaluate a blended learning web-based media called Vocationality, designed to support project-based learning in Creative Products and Entrepreneurship (PKK) at vocational high schools. Quantitative data were collected through surveys involving 94 students who used the platform during blended learning activities. **Novelty:** The study adopted the waterfall model as the framework for the development of the Vocationality platform, encompassing stages of analysis, design, development, implementation, and evaluation. The evaluation focused on four main aspects: usability, content quality, interactivity, and user satisfaction. Descriptive statistical analysis was used to assess the platform's effectiveness, and results were further validated through literature comparison and theory-driven interpretation. **Result:** The results indicated that Vocationality effectively enhanced students' access to practical materials, facilitated self-directed learning, and increased engagement through multimedia-based content and asynchronous discussion forums. Students reported high levels of satisfaction, particularly regarding the clarity of content and ease of use. The integration of features such as digital portfolios and self-assessment tools also supported reflective learning and competency tracking. In conclusion, the Vocationality platform demonstrates strong potential as an adaptive and pedagogically sound learning management system (LMS) for vocational education. Future development should focus on strengthening collaborative features and integrating learning analytics to enhance personalization and feedback mechanisms.

INTRODUCTION

Vocational education in Indonesia aims to prepare work-ready graduates, but in the Creative Products and Entrepreneurship (PKK) subject, practical effectiveness has not been optimal, especially during the COVID-19 pandemic (Handayani et al., 2020). Blended learning has become the dominant approach in vocational education since 2020, but its effectiveness is highly dependent on the learning model used, such as flipped classroom, station rotation, and self-blend (Basori et al., 2022). A systematic review of 32 blended learning studies in vocational high schools found that the design and management dimensions contributed 39% to learning effectiveness and increased student knowledge by up to 42% (Handayani et al., 2020). However, the availability of structured digital learning media for PKK remains very limited.

The literature on technology education shows a strong trend towards the use of digital learning technologies after 2019, but there has been little focus on vocational practical applications (Kimmons & Rosenberg, 2021). Gamification platforms have shown potential to increase student engagement, but their implementation in vocational high school practical media remains limited (Toda et al., 2020). Furthermore, the need

for 21st-century competencies such as higher-order thinking skills (HOTS), digital literacy, and entrepreneurship requires active and interactive media that support project-based learning (Graham, 2022).

Global vocational education analysis highlights the importance of integrating digital resources and hands-on practice to improve students' technical competencies (DataCalculus, 2023). The waterfall model remains a relevant approach to educational system development due to its systematic structure, comprehensive documentation, and cost-effectiveness (Sherrell, 2013; Simulação Waterfall, 2025). Therefore, this study aims to develop web-based digital learning media integrated into a portfolio-based learning management system (LMS) for the PKK subject, using the waterfall development model and measured through four aspects of effectiveness: usability, information, interaction quality, and user satisfaction. This study fills a gap in the literature that has not systematically examined the development of portfolio-based learning management systems (LMS) for project-based practical learning in entrepreneurship subjects at vocational schools in Malang Regency.

RESEARCH METHOD

This research uses a Research and Development (R&D) approach. The Vocationalogy web application development model is adapted from Pressman's (2015) waterfall model, a classic model that is systematic and sequential in building software. The name of this model is actually "Linear Sequential Model". This model is often also called the "classic life cycle" or waterfall method. It is called waterfall because each stage must wait for the completion of the previous stage and runs sequentially. The phases in the Waterfall Model according to Pressman's reference are shown in the image below:

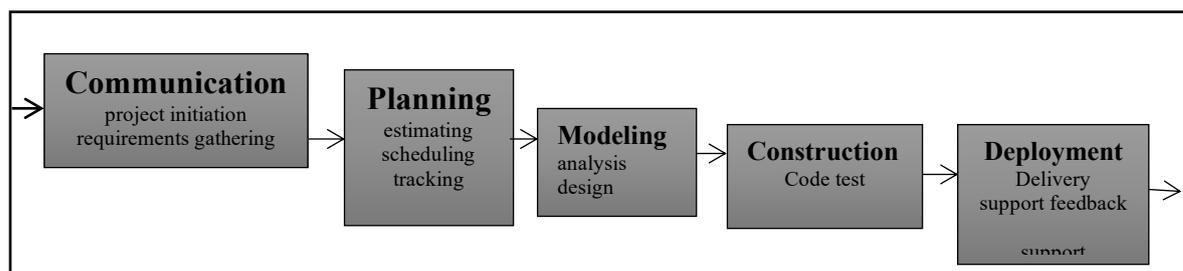


Figure 1. Waterfall Model (Pressman, 2015)

In the Communication phase, needs were identified through interviews with PKK teachers and curriculum heads at vocational schools throughout Malang Regency to understand the content and features required for the learning media. In the Planning phase, time estimates, resource allocation (hosting, domain, developers), and development stage scheduling were conducted. The Modeling phase involved designing the system architecture, user interface, and student portfolio structure. The Construction phase involved coding Google Sites-based pages, followed by internal (alpha) and external (beta) testing. Deployment included media implementation at four partner vocational schools, teacher training, feedback collection, and further development.

The data collection for this study involved both qualitative and quantitative methods: 1) Qualitative Data: In-depth interviews were conducted with teachers and curriculum heads to understand the content and feature requirements for the platform.

Additionally, observational data were collected during the field trials to assess how students interacted with the platform. 2) Quantitative Data: A structured questionnaire was used to measure four key aspects of the platform: usability, content quality, interactivity, and user satisfaction. The questionnaire used a Likert scale to rate responses, with options ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). This scale was selected based on its widespread use in educational technology research and its ability to capture variations in user perceptions.

Data collection was conducted through interviews, observations of 60 students' media use, and analysis of documentation and student portfolios. Data validity was strengthened through triangulation of sources and methods with expert validation and field trials in ensuring the platform's effectiveness and practical applicability in vocational education. The integration of expert feedback and rigorous testing throughout the development phases significantly enhanced the platform's pedagogical value and its ability to support project-based learning in vocational high schools. Data analysis was conducted using descriptive qualitative and simple quantitative methods based on questionnaire results related to four aspects of media effectiveness.

RESULTS AND DISCUSSION

Results

Website Development

The development of the Vocationalogy web-based learning media follows a structured and systematic approach as detailed in the research framework. The platform's development was guided by the Waterfall Model and divided into five main phases: Communication, Planning, Modeling, Construction, and Deployment. These stages on Figure 2 were designed to ensure that the web application meets the pedagogical goals of enhancing vocational learning in the PKK subject.

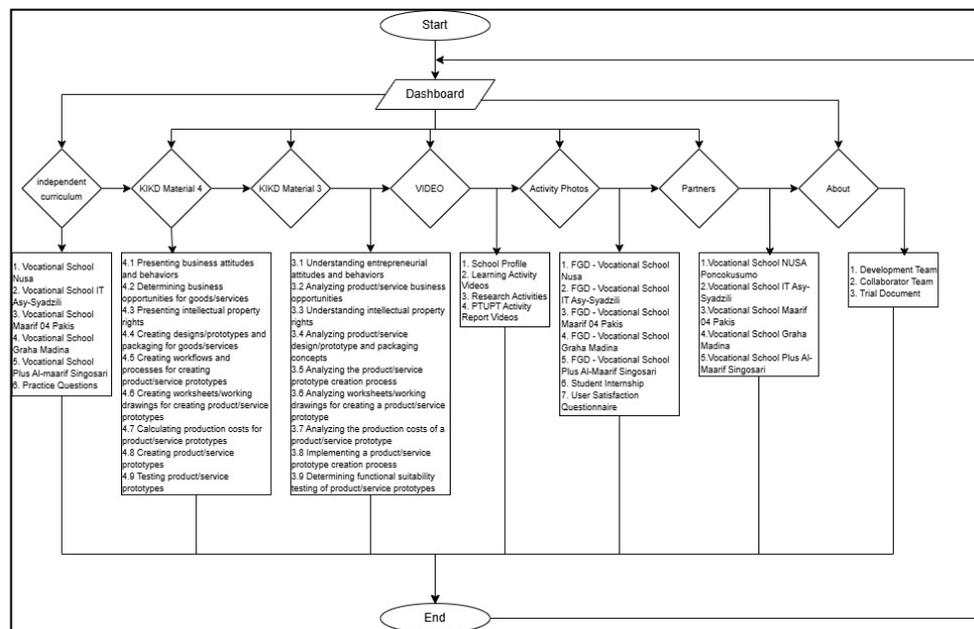


Figure 2. Website System Flowchart

The flowchart outlines the process of developing the Vocationalogy web-based learning platform, designed to enhance practical learning in vocational schools. The

development process follows a sequential path that starts from the home page and progresses through various stages, involving key components such as curriculum, video content, partner schools, and system feedback. Below is a detailed breakdown of the flowchart:

1. Start: The process begins at the "Start" point, where the home page (referred to as "Beranda") is displayed. This serves as the entry point to the system.
2. Curriculum Selection: From the home page, users can choose between different curriculum pathways:
 - a. Kurikulum Merdeka (Independent Curriculum): This pathway offers content that aligns with Indonesia's independent curriculum for vocational education.
 - b. After selecting the curriculum, the user is directed to further content options, including subject matter for KIKD-4 and KIKD-3, which correspond to specific vocational competencies and knowledge areas in the curriculum.
3. Competency Areas (KIKD-4 and KIKD-3):
 - a. KIKD-4: Covers topics such as entrepreneurship, understanding business opportunities, designing prototypes for products/services, and calculating production costs. This section includes lessons like:
 - 1) Presenting entrepreneurial attitudes and behaviors.
 - 2) Analyzing business opportunities.
 - 3) Designing product/service prototypes.
 - 4) Creating work documents related to product prototype development.
 - b. KIKD-3: Focuses on understanding and analyzing entrepreneurial behavior and product/service concepts, and includes lessons on:
 - 1) Understanding business concepts.
 - 2) Developing work processes for product prototype creation.
 - 3) Analyzing production costs and product testing.Depending on the competency area selected (either KIKD-4 or KIKD-3), the user is led to corresponding sub-sections that focus on either prototyping or conceptualizing business opportunities.
4. Video Content and Activities: Users are then directed to sections containing various video content:
 - a. School Profile: Features a video introduction to the vocational school.
 - b. Learning Activity Video: Demonstrates practical learning sessions.
 - c. Research Activities Video: Provides insights into ongoing research or projects.
 - d. Activity Video: Highlights activities
5. Activity Photos and Partners: The system then navigates to Activity Photos and Mitra (Partners):
 - a. Activity Photos: Displays photos documenting various school activities, including student participation in learning and development.
 - b. Partners: Lists the partner schools involved in the program, providing insights into collaboration. The partner schools include:
 - 1) SMK Nusa Poncokusumo Pakis
 - 2) SMK IT Asy-Syadzili 5
 - 3) SMK Plus Almaarif Singosari
 - 4) SMK Maarif 04 Pakis
 - 5) SMK Graha Madina

6. FGD and User Feedback: The flowchart also leads to an FGD (Focus Group Discussion) section, where data is gathered from the participating vocational schools:
 - a. FGD-SMK Nusa Poncokusumo Pakis
 - b. FGD-SMK IT Asy-Syadzili 5
 - c. FGD-SMK Plus Almaarif Singosari
 - d. FGD-SMK Graha MadinaAdditionally, an Angket Kepuasan Pengguna (User Satisfaction Survey) is conducted to gather feedback from users about their experience with the platform.
7. About Section: Finally, the flowchart includes an About section, which provides additional information about the platform's development team, collaborators, and documentation:
 - a. Team Pengembang (Development Team): Information about the team that developed the platform.
 - b. Tim Kolaborator (Collaborators): Details on the partners and collaborators involved in the project.
 - c. Dokumen Uji Coba (Test Documentation): Contains documentation related to testing the platform before its launch.
8. End:
The process concludes at the "End" point, marking the completion of the navigation through the platform.

This flowchart effectively visualizes the path users take through the Vocationalogy web-based platform, detailing key stages from curriculum selection to user feedback. The sequential flow ensures that the platform is structured to support the development of vocational competencies in a logical and user-friendly manner.

Effectiveness of Media Development Results

The results of the web-based Vocationalogy media development show statistical data that illustrates its effectiveness in supporting practical learning of the PKK subject in vocational schools. The effectiveness assessment is divided into four main categories: usability, information quality, interaction quality, and user satisfaction. See on the Figure 3.

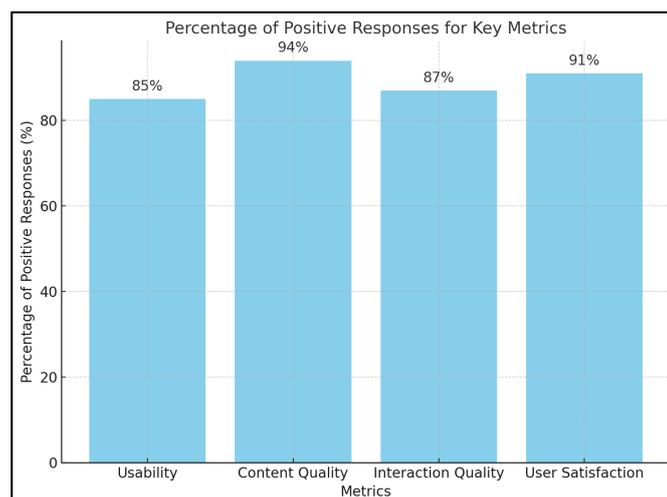


Figure 3. The Bar Chart of Percentage of Positive Responses

Based on the results of a questionnaire given to 60 respondents from five partner vocational schools, the following results were obtained: in the usability category, 85% of respondents stated that the media was very easy to use, 87% considered the display attractive, and 83% said that the interface navigation was very easy. In the information quality category, 94% stated that the information content was accurate, easy to understand, and relevant to the curriculum. For interaction quality, 87% felt safe in use and easy to access, but only 73% said the discussion feature was quite active. Meanwhile, in terms of user satisfaction, 94% stated that they were satisfied with the media overall, 91% felt that the learning videos were easy to access, and 94% considered the media to significantly support practical learning.

Media Design and Features

Vocational learning media provides digital learning packages such as lesson plans (RPP), student worksheets (LKPD), learning videos, discussion rooms, and digital student portfolios. This media design is responsive and compatible with mobile devices. This aims to support flexibility in blended learning and the implementation of project-based learning that aligns with 21st-century competencies. The navigation structure and interface are intuitively designed to encourage active student participation. Content is aligned with the needs of the PKK curriculum in vocational high schools (Graham, 2022; Mercan et al., 2024). The application of interactive elements in learning media has been proven to increase student engagement in the learning process. This finding is supported by research results showing an increase of up to 35% in student engagement levels when using interactive digital platforms. Platforms designed with user experience in mind have a significant impact on student learning motivation (Saliba et al., 2020).

Web-based media like Vocational learning media also support flexible content management by teachers. This allows teachers to quickly adapt and update learning materials according to class dynamics. This aligns with previous studies that emphasized the importance of customization features in LMSs to increase material relevance (Chan et al., 2021). Students' preference for mobile-accessible learning platforms is a key consideration in design development. A survey of vocational high school students showed that the majority are more comfortable using learning media accessible from smartphones. This accessibility support also contributes to digital education inclusion (Ahmed & Opoku, 2022).

The digital portfolio feature in this media provides students with a platform to document their learning process and practical outcomes. This feature has been shown to increase reflective awareness and motivate students to continuously improve their performance. Previous research has shown that digital portfolios are effective in enhancing self-assessment and responsibility for learning (Zhang et al., 2023). This media structure also accommodates the Universal Design for Learning (UDL) principles, which support diverse student learning styles. This allows students with different learning needs to access materials and optimally participate in the learning process. This approach aligns with the goals of inclusive education in a digital context (Hall et al., 2021). Furthermore, the presentation of visual content, such as videos and infographics, has been shown to be effective in enhancing students' information retention in vocational education. The presence of relevant visual media can strengthen

conceptual understanding and help students connect theory with practice (Lim & Wang, 2020).

Discussion

Usability Evaluation

Evaluation results showed that the majority of respondents found the media easy to use and intuitive to navigate. Design that prioritizes user comfort is crucial to ensure the continued use of online learning media. Usability in e-learning platforms has been identified as a key factor determining the acceptance and effectiveness of learning. Easy-to-use platforms tend to increase student motivation and learning independence (Yusop et al., 2022). The Model of Mobile Learning (MML) states that the success of a learning medium depends on technological, pedagogical, and social dimensions. These three aspects have been integrated into the Vocationalogy media. This integration facilitates users in understanding the overall learning flow (Koole, 2020).

User experience also plays a crucial role in enhancing the perceived usefulness of a platform. When students feel comfortable using the platform, they are more likely to actively participate in the learning process. This is evident in the increased student engagement in systems with well-designed interfaces (Lwoga, 2021). Ease of use is also closely related to student learning outcomes. Previous studies have found that high usability in an LMS positively contributes to improved student conceptual understanding. User-friendly platforms also allow students to focus more on the content without being distracted by technical aspects (Alshammari et al., 2020).

Students who use an easy-to-use LMS demonstrate higher levels of learning motivation. This reflects the importance of simple yet effective features in supporting the learning process (Noroozi & Hatami, 2021). Visual displays and interactive elements in the media also contribute to improving student focus. Visually appealing platforms are more likely to be selected by students and result in longer usage times. This supports the importance of visual design in developing learning media (Ghavifekr & Rosdy, 2022). Media Vocationalogy successfully created an interface that is not only attractive but also functional. This reinforces the finding that a combination of visual design and good navigation structure is key to a successful digital learning system.

Information Quality Evaluation

Vocationalogy Media is designed to provide relevant, accurate, and compliant information aligned with the vocational education curriculum. Respondents stated that the information available on the platform is easy to understand and presented systematically. This indicates that well-structured digital content in a well-structured LMS is crucial in supporting students' conceptual understanding. Platforms that provide comprehensive information are more effective in self-paced learning environments. The clarity and accuracy of the information provided strengthen the validity of the materials used in the learning process (Sun et al., 2020). Previous studies have shown that consistent and organized material delivery is a crucial factor in improving the quality of online learning. Research suggests that the structure and organization of information influence students' perceptions of the educational value of a digital platform. Therefore, the presence of media that presents material in a logical sequence and with clear visuals will accelerate student absorption. LMSs that offer well-organized content-based navigation also tend to improve student information retention.



Consistency and structure in information delivery are key determinants of LMS effectiveness (Bao, 2020).

Students also tend to be more interested in using learning media that present information multimodally. In this case, information is delivered not only textually but also through videos, images, and interactive simulations. Studies have found that multimedia content can increase student cognitive engagement. It also supports diverse learning styles in heterogeneous classrooms. Variation in material delivery provides greater opportunities for students to understand and retain information (Chen et al., 2021). Content development in Vocationalogy has considered pedagogical principles in material development, including adapting it to learning objectives and student competency levels. Research indicates that digital curricula developed based on learning outcomes are more effective than conventional materials. Furthermore, the integration of theory and practice in the form of simulations or case studies has been shown to foster in-depth understanding. Content development based on a learning taxonomy is also considered more supportive of learning outcomes (Hew et al., 2021).

The alignment between learning materials and curriculum requirements is a key indicator of the effectiveness of learning media. An LMS that successfully provides information tailored to user needs has greater potential to improve learning outcomes. Contextual and industry-based material development makes learning more meaningful. In the context of vocational education, this is crucial for bridging the gap between education and the workplace. The relevance of the material significantly influences technology adoption by teachers and students (Zhang & Zhu, 2022). Media that provides comprehensive and detailed information will be more readily accepted by teachers as an enrichment tool. This facilitates the integration of the LMS into direct classroom learning. The availability of additional resources such as question banks, lab guides, and integrated modules adds value to Vocationalogy. When teachers feel supported by the comprehensiveness of the content, adoption of digital media increases. Additional materials also allow for a variety of teaching strategies (Hwang & Chang, 2021).

The appropriateness of the format and structure of information presentation in media also influences users' perceptions of its professionalism. Using a clean, consistent, and proportional layout supports clarity of the message. This is crucial in the context of an LMS, as students tend to lose focus when content appears cluttered. Therefore, digital-based learning media must adhere to educational graphic design principles. The visual elements used must also support understanding of the content (Delianti & Jalinus, 2020).

Interaction Quality

Interaction in digital learning is a crucial element in enhancing the effectiveness of the teaching and learning process. Vocationalogy Media provides discussion forums as a means of interaction between students and teachers, although their use is still limited. Survey results indicate that most students feel the platform is safe enough to access and use. However, there are shortcomings in maximizing user utilization of the discussion feature. The quality of interaction still needs to be improved so that this platform truly supports active collaboration in project-based learning (Hrastinski, 2021). Project-based learning requires active participation and meaningful discussions between students. Therefore, two-way communication features are crucial in an LMS. Research shows that

well-designed discussion forums can significantly increase student engagement and support learning reflection. One way to increase participation is by providing relevant and structured discussion topics. Active participation in online forums reflects the extent to which students feel engaged in digital learning (Martin et al., 2020).

Another study showed that participating in online discussions can increase a sense of ownership in the learning process. By increasing the sense of connection between students and teachers, the learning environment becomes more conducive and supports cognitive development. LMSs that provide open communication features tend to be more effective in building learning communities. This makes interaction in digital media a key component in creating a comprehensive learning experience. Vocationalogy Media needs to expand this interaction space to make it more functional (Kim et al., 2021). In addition to technical aspects, social aspects also influence the effectiveness of discussion forums. When students are given the freedom to express their opinions, the learning process becomes more inclusive. Research shows that online discussions that provide space for expression can increase students' intrinsic motivation. Providing open reflection space also promotes in-depth conceptual understanding. Therefore, media development must consider social dynamics in its interaction design (Deng & Tavares, 2020).

Active interaction between LMS users has also been shown to accelerate student completion of assignments and projects. A study on digital learning found that students who actively engaged in discussions understood project instructions more quickly. This indicates that effective discussion features can promote better learning outcomes. Interactive digital media not only conveys information but also encourages collaboration. Therefore, strengthening discussion features is a strategic step in developing Vocationalogy (Zhou et al., 2022). Collaborative learning facilitated by an LMS also impacts the development of 21st-century skills. Through discussion forums, students learn to express opinions, discuss, and listen to others' perspectives. This process is crucial for developing critical thinking and teamwork skills. Research suggests that students who actively participate in online discussions demonstrate significant social skill development. Therefore, strengthening the interaction aspect of the media needs to be a priority for future development (Akyol et al., 2020).

Media that facilitates asynchronous interaction also gives students time to think more deeply before responding. This model can improve the quality of discussions because students don't feel pressured by time constraints. This creates space for reflection and further exploration of ideas. An LMS that allows for flexibility in discussion can improve the quality of students' arguments. Vocationalogy can adopt this approach to strengthen its learning effectiveness (Noroozi & Hatami, 2021).

User Satisfaction and Practical Impact

User satisfaction is a crucial indicator in assessing the success of digital learning media implementation. Survey results showed that 94% of respondents were satisfied with Vocationalogy overall. This was supported by its ease of access, attractive appearance, and the content's suitability to the needs of vocational high school students. A high level of satisfaction indicates that the medium has met user expectations in supporting practical learning. An LMS designed to meet user needs is more likely to be widely adopted (Bączek et al., 2021). One factor influencing user satisfaction is the availability of content that aligns with learning objectives. Students tend to be more



satisfied when the material provided is relevant and supports hands-on practice. Furthermore, easily accessible learning videos accelerate the learning process and enrich the learning experience. Adaptive content also encourages students to learn independently. High levels of satisfaction demonstrate that this medium aligns with vocational learning needs (Al-Fraihat et al., 2020).

Research also shows that LMSs that support content personalization and high accessibility tend to increase student engagement. When students perceive the media as adaptable to their learning styles, they are more likely to actively participate in learning. This has a direct impact on learning outcomes and student motivation. Flexible digital media is one learning solution in the digital age. Vocationalogy meets most of these criteria (Bernard et al., 2021). The presence of digital portfolios in LMSs allows students to systematically document their work. This provides space for reflection and gradual improvement in project quality. Students also feel more accountable for their learning outcomes because they have tangible evidence of their achievements. This feature also allows teachers to conduct ongoing assessments. Digital portfolios are an effective tool in project-based learning (Ouyang & Scharber, 2021).

In digital learning media, active student participation is a key factor in determining the success of the platform. When students feel in control of the learning process, they are more enthusiastic about completing assignments and following instructions. An LMS that supports freedom of learning encourages increased participation. This is evident in the increasing number of practical assignments successfully submitted through the system. Vocationalogy supports this model well (Trust & Whalen, 2020). Studies indicate that an LMS with effective interactions can significantly improve student practical assignment results. When students feel guided and supported by the system, they are more likely to complete assignments on time. This is crucial in the context of vocational education, which demands precision and efficiency. The use of an LMS can facilitate this achievement. These results reinforce previous findings on the effectiveness of digital platforms (Yang et al., 2023).

The self-assessment feature in this platform also helps students understand their learning progress. This allows them to address weaknesses early on and strengthen their strengths. This aspect not only impacts final results but also fosters a lifelong learning mindset. Self-assessment is a crucial component of character education in a digital context. Vocationalogy contributes positively to this (Lee et al., 2020)

CONCLUSION

The results of this study indicate that the development of Vocationalogy web-based learning media integrated with a blended learning approach can significantly contribute to the effectiveness of the learning process in vocational schools, particularly in the context of project-based practical learning. This platform has been designed and implemented by considering the pedagogical needs, technology, and characteristics of vocational students, thereby increasing access to teaching materials, learning flexibility, and student engagement in a student-centered learning process.

In terms of information quality, this medium has proven capable of providing relevant, systematic, and curriculum-aligned learning content. The clarity of the structure and the use of multimodality in delivering the material strengthen students' understanding of vocational concepts. This finding is supported by various studies showing that information quality and content design have a significant impact on the

success of online learning. The interactive aspect of Vocationalogy also shows potential in building a collaborative learning ecosystem, although optimization of the discussion feature is still needed to encourage active student engagement in meaningful discussions. The social interaction facilitated through asynchronous forums provides space for students to reflect and construct knowledge independently and collectively, as emphasized in recent literature on digital learning communities.

User satisfaction with this platform is very high, both in terms of ease of access, usability, and usefulness in supporting student work experience. The use of digital portfolios, self-assessments, and practice videos has been shown to increase student motivation and confidence in completing practical assignments. This aligns with the student-centered learning approach, which emphasizes personalization and empowering students to manage their own learning process. Overall, the Vocationalogy learning platform not only meets the technical requirements for waterfall-based software development but also successfully integrates the principles of digital pedagogy and the needs of the workplace. Therefore, this LMS development can be an adaptive and applicable model for vocational learning in the digital era. For future development, the integration of deeper interactive features and support for learning analytics will further enrich the platform's functionality.

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