Journal of Informatics and Vocational Education (JOIVE)
Vol.9, No.1, January 2026, pp. 49~57
ISSN: 2746-7813

Learning Barriers in Web Programming Subjects Among Vocational Software Engineering Students: A Qualitative Case Study

Akbar Wiguna*[1], Rahmania Sri Untari[1], Fitria Nur Hasanah[1], Cindy Cahyaning Astuti[1], Arsyah Agas Awwaby[1]
[1] Information Technology Education, Universitas Muhammadiyah Sidoarjo, Indonesia

Article Info

Article history:

Received Oct 21, 2025
Revised Jan 26, 2026
Accepted Feb 1, 2026

Corresponding Author:

Akbar Wiguna,
Universitas Muhammadiyah Sidoarjo
Jl. Mojopahit No.666 B,
Sidowayah, Celep, Kec. Sidoarjo,
Kabupaten Sidoarjo, Jawa Timur,
Indonesia 61215
Email:
akbar.wiguna@umsida.ac.id

ABSTRACT

This study examines the learning difficulties experienced by vocational high school (SMK) students in the Computer and Network Engineering (TKJ) program in learning web programming. A qualitative case study approach was employed, involving semi-structured interviews, observations, and documentation with 21 students from SMK Negeri 2 Buduran. Data were analyzed using thematic analysis supported by descriptive questionnaire results. The findings show that all students perceived web programming as challenging, with 71% rating it as very difficult and 29% as moderately difficult, while none considered it easy. In terms of learning enjoyment, 76% of students reported a neutral level of enjoyment, indicating limited intrinsic motivation. The analysis revealed several dominant learning barriers, including difficulties with programming syntax and logic, challenges in using development tools such as VSCode and terminal environments, limited access to clear learning resources, and insufficient instructional guidance. Emotional factors, such as frustration and stress caused by repeated errors, further hindered the learning process. Students also identified programming, networking (e.g., TCP/IP and server administration), and microcontroller-related subjects as the most difficult areas within the curriculum.

These findings indicate that students' learning difficulties in web programming are not only technical but also instructional and affective in nature. Therefore, this study emphasizes the need for more interactive, supportive, and student-centered learning strategies. The adoption of project-based learning, enhanced digital learning resources, and guided mentorship is recommended to improve students' competencies, motivation, and confidence in web programming. The results provide valuable insights for educators, curriculum developers, and policymakers in strengthening vocational education to better meet industry demands.

Keywords: Web programming, learning difficuties, students, vocational education

1. INTRODUCTION

Web programming is one of the key competencies taught in the curriculum of Vocational High Schools (SMK), particularly in the Computer and Network Engineering (TKJ) (Sorongan et al., 2022) (Muslim et al., 2024). This skill has become increasingly crucial amid the rapid advancement of digital technology, which has driven nearly all industrial and business sectors to establish a digital presence through applications or websites. Therefore, the ability to build, develop, and maintain websites is no longer just an additional skill but a fundamental requirement for Computer and Network Engineering (TKJ) graduates. Unfortunately, real-world observations reveal that many students struggle to grasp web programming concepts, whether in terms of foundational principles, the application of programming logic, or mastering the various technologies used in modern web development(Park & Wiedenbeck, 2011).

The difficulty in learning web programming is not entirely new. Previous research by (Gomes & Mendes, 2007) shows that programming learning, in general, is a complex process because students must simultaneously understand syntax, logic, and code structure. (Robins et al., 2016) (Piwek et al., 2019) add that many beginners feel overwhelmed by new terminology and struggle to connect theory with practical implementation. This also applies to web programming, which, although often considered easier due to its visual nature, presents its own challenges—especially in integrating HTML, CSS, JavaScript, and the use of ever-evolving modern frameworks.

This situation is exacerbated by teaching methods that remain dominated by conventional, theory-heavy approaches(Govindaraju et al., 2023). Many teachers have yet to optimize contextual or project-based learning in teaching web programming(López-Pimentel et al., 2021). In fact, project-based learning has been proven effective in enhancing students' understanding of complex material, particularly in technology and engineering. (Barron & Chen, 2008) state that project-based learning actively engages students in the learning process, improves problem-solving skills, and facilitates a deeper understanding of abstract concepts. In the context of web programming, this method can provide hands-on experience by having students build real-world projects such as portfolio websites, blogs, or simple e-commerce sites(Rudewicz & Sala, 2021).

Beyond teaching methods, students' learning difficulties are also influenced by contextual factors encountered in the field, particularly limitations in infrastructure, access to learning resources, and support for self-directed learning. Field observations and interview data revealed that several students experienced technical constraints, such as inadequate personal devices and the need to install additional software to run web programming tools effectively. Some students explicitly mentioned difficulties related to development environments, such as confusion when using VSCode and terminal-based commands, as well as hardware limitations that hindered smooth practice during and outside classroom sessions.

In addition, students reported challenges in accessing clear and structured digital learning resources independently. Although online tutorials and video-based materials were available, many students perceived them as unclear, incomplete, or difficult to follow without direct guidance from teachers or peers. This indicates relatively low digital literacy and limited experience in utilizing online documentation or programming communities for problem-solving. These field findings are consistent with previous studies showing that limited infrastructure and insufficient access to digital learning resources can significantly hinder the effectiveness of web programming instruction in vocational schools(Muntholib et al., 2018). Moreover, (Nugroho et al., 2023) emphasize that low digital literacy restricts students' ability to engage in autonomous learning, which in turn widens the gap between expected competencies and students' actual (Almdahem, 2019).

Given this phenomenon, a clear disparity emerges between the job market's increasing demand for graduates with web programming competencies and the actual learning conditions experienced by students in Vocational High Schools. At a general level, industry expectations require TKJ graduates to possess not only basic coding skills but also the ability to apply programming logic, use development tools, and solve real-world problems effectively(Javier, 2017). However, at the field level, direct observations and interview data from this study reveal that many TKJ students struggle with fundamental aspects of web programming, such as understanding syntax, applying logical reasoning, and utilizing development environments.

This gap indicates that the competencies expected at the macro level are not yet fully supported by learning experiences at the micro level. While web programming is positioned as a core competence within the TKJ curriculum, students' actual mastery remains limited due to a combination of pedagogical, technical, and contextual constraints encountered during the learning process. Based on these field-based conditions, the present study was conducted to systematically examine the specific forms of learning difficulties faced by TKJ students, identify the contributing factors underlying these difficulties, and explore potential strategies to bridge the gap between industry demands and classroom realities. Accordingly, this study addresses the following research questions: (1) What are the main difficulties faced by TKJ students in learning web programming? and (2) What factors contribute to these difficulties?

The primary objective of this study is to identify in detail the forms of difficulties students encounter in learning web programming, analyze the root causes, and formulate targeted learning recommendations. The findings are expected to provide constructive input for teachers, department heads, and curriculum developers at Vocational High School to design more adaptive, student-centered learning strategies.

Recent research on programming education has predominantly focused on evaluating the effectiveness of specific instructional approaches, such as project-based learning, gamification, collaborative coding, and computational thinking development. For instance, (Zhang et al., 2024) demonstrated that project-based learning significantly enhances students' computational thinking and problem-solving skills, while (Papastergiou, 2009) reported positive effects of game-based and simulation-based learning on students' motivation and performance in computer science education. Other studies have emphasized the role of digital learning media, blended learning, and interactive platforms in improving programming comprehension and engagement.

However, despite these advances, relatively limited attention has been given to in-depth qualitative investigations that explore students' learning difficulties in web programming from their own perspectives, particularly within the context of vocational education. Many existing studies focus on learning outcomes or intervention effectiveness, rather than examining the underlying barriers—such as cognitive, technical, emotional, and contextual factors—that students experience during the learning process. Moreover, empirical evidence from Indonesian Vocational High Schools remains scarce, even though web programming is positioned as a core competency for TKJ students.

Therefore, this study contributes to the current state of the art by providing a qualitative, field-based analysis of web programming learning barriers among vocational students. By capturing students' perceptions, experiences, and challenges through interviews and observations, this research complements prior outcome-oriented studies and offers a contextualized understanding of why learning difficulties persist. The results are expected to serve as a foundation for developing learning modules, project-based teaching models, and teacher training strategies tailored to the characteristics of Vocational High School students. In a broader context, this study contributes to improving the quality of vocational education in Indonesia and aligns with the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education) and SDG 8 (Decent Work and Economic Growth), by supporting the development of industry-relevant competencies among vocational graduates.

2. RESEARCH METHOD

This research uses a qualitative approach with a case study method. Researchers analyzed the needs of students in learning in object-based programming courses. This research will describe the analysis of the needs of Information Technology Education students for learning media in the Object-Based Programming course. The presence of the researcher acts as a key instrument during data collection, as well as a planner, as a data collector, as data analysis, as data interpretation, and as a reporter of research results.

This research was conducted at the SMK Negeri 2 Buduran on students of Teknik Komputer dan Jaringan who were attending web Programming courses. The data in this study were obtained from the results of extracting students through a researcher approach. The data obtained is the result of extracting from students is the main data source of qualitative data. Qualitative data in this study consisted of students perception towards web programming course, Web programming is considered an enjoyable subject by the student, Difficulty is experienced by the student in learning web programming, Various difficulties are experienced by the student during web programming lessons and One subject in Computer and Network Engineering (TKJ) is considered the most difficult by the student. Subjects/informants are determined by purposive sampling technique. The informants that will be used in this research are students who are attending web Programming courses, which are described in Table 1.

Table 1. The performance of speed

Class	Number of Subjects
XI TKJ	21

The data collection techniques used by researchers are interviews, observations, documentation, and triangulation. The instruments used in this research are interviews, document studies, and observations. The flow of individual case data analysis can be seen in Figure 1.

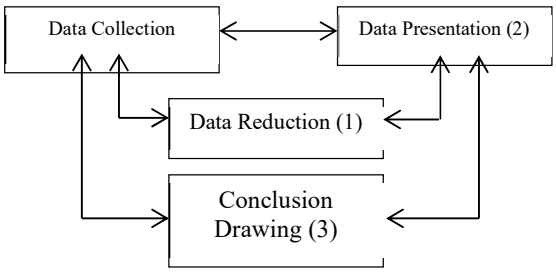

Figure 1. Effects of selecting different switching under dynamic condition

The data collection techniques used by researchers are interviews, observations, documentation, and triangulation. The instruments used in this research are interviews, document studies, and observations. The flow of individual case data analysis can be seen in Figure 1. Figure 1: Flow of Individual Case Data Analysis.

Initial Preparation Stage

a) Research planning, identification of the problem to be studied, and preparation of the research framework.
b) Selection of research locations based on relevant theoretical considerations, as well as in-depth research to understand the focus and formulation of the problem.
c) Selection of informants in accordance with the research objectives.
d) Preparation of equipment and materials needed for research.
e) Maintaining good relations with the research environment and paying attention to local norms and customs in dealing with the research situation.

Field Implementation Stage

Before using the research instruments, discussions will be held with experts in the field of information technology education. Data validity in this study is planned to be tested through follow-up observations and triangulation with other informants who have an understanding of the topic.

3. RESULT AND ANALYSIS

This study aimed to explore the learning difficulties faced by vocational high school students in the Software Engineering (TKJ) program regarding web programming. The interviews were conducted on December 20, 2024. The list of interview questions related to students' difficulties in learning web programming in the Software Engineering (TKJ) program is shown in Table 2.

Table 2. Interview Questions

No	Question
1	How do you perceive web programming?
2	Is web programming an enjoyable subject for you?
3	Do you find it difficult to learn web programming?
4	what difficulties do you experience in learning web programming?
5	According to you, which subject in Computer and Network Engineering (TKJ) is the most difficult?

Interviews on the first question "How do you perceive web programming" that was conducted on December 20, 2024 to 16 students who have been selected get the results as the majority of students perceive web programming as **very difficult**. The questionnaire results as shown at Table 3 reveal a clear pattern indicating that students predominantly perceive web programming as a challenging subject. As summarized in the questionnaire data, 15 out of 21 students (71%) rated web programming as "very difficult," while the remaining 6 students (29%) perceived it as "moderately difficult." Importantly, none of the respondents categorized web programming as an easy subject.

Table 3. Students Perceptions of Web Programming Difficulty

Perception Level	**Frequency**	**Percentage**
Very Difficult	15	71%
Moderately Difficult	6	29%
Easy	0	0%
Total	**21**	**100%**

From an analytical perspective, this pattern reflects a widespread struggle among students in coping with the cognitive demands of web programming, including understanding syntax, applying programming logic, and integrating multiple technologies. The absence of positive responses ("easy") further indicates that existing instructional practices and learning support mechanisms may not yet be sufficient to facilitate students' conceptual

understanding. This finding aligns with (Mbiada et al., 2023) who reported that novice learners often perceive programming as difficult due to the complexity of abstract concepts and the accumulation of technical errors, which can negatively affect confidence and persistence in learning.

This finding is in line with previous research highlighting the challenges students face in learning programming. For example, (Dirzyte et al., 2021) found that many students struggle with understanding abstract programming concepts, which contributes to the perception that programming is difficult. Similarly, (Papastergiou, 2009) noted that students often experience anxiety and low confidence when engaging with programming tasks, especially in web-based environments. These studies support the current finding that a majority of students perceive web programming as very difficult, indicating a consistent pattern of learning difficulties in programming education.

The interview on the second question, " Is web programming an enjoyable subject for you?" which was conducted on December 20, 2024 to 21 students who have been selected to get the results as shown in Table 4. The questionnaire results indicate that students' enjoyment of learning web programming tends to be neutral rather than positive. As summarized in the questionnaire data, 16 out of 21 students (76%) rated their learning experience as "average," while only 3 students (14%) reported that web programming is "very enjoyable." In contrast, 2 students (10%) stated that they do not enjoy learning web programming.

Table 4. Students' Enjoyment of Learning Web Programming

Enjoyment Level	Frequency	Percentage
Very Enjoyable	3	14%
Average	16	76%
Not Enjoyable	2	10%
Total	**21**	**100%**

This distribution suggests that although negative affect is relatively limited, positive engagement remains low. The dominance of "average" responses indicates that web programming has not yet become an intrinsically motivating subject for most students. From an analytical perspective, this neutral enjoyment level may be associated with instructional practices that emphasize technical completion over meaningful interaction, exploration, and creativity. When learning activities are perceived as routine or overly focused on syntax and error correction, students may remain emotionally disengaged despite recognizing the importance of the subject. These findings imply that enjoyment in web programming is highly dependent on the extent to which learning activities are interactive, contextual, and supportive of active student involvement.

This finding is in line with (Djenic et al., 2011), which highlights that the use of interactive learning media enhances students' interest and enjoyment in learning programming by visualizing abstract concepts and actively involving them in the process. Similarly, (J. B. Santos et al., 2024) (P. S. C. Santos et al., 2018) found that integrating media-based activities—such as image creation—into programming lessons significantly boosts student motivation and comprehension. These studies support the current result, in which only a small portion of students found web programming to be very enjoyable, indicating the need for more engaging and interactive approaches to improve students' learning experiences and satisfaction.

The interview on the third question, "Do you find it difficult to learn web programming?" which was conducted on December 20, 2024 to 21 students who have been selected to get the results as shown in Table 5. The questionnaire results show that learning difficulties in web programming are experienced by nearly all students. Based on the responses of 21 students, 9 students (43%) stated that they frequently experience difficulties in learning web programming, while 11 students (52%) reported that they sometimes encounter difficulties depending on the topic or learning situation. Only 1 student (5%) indicated that they do not experience any difficulty.

Table 5. Students' Reported Difficulties in Learning Web Programming

Response Category	Frequency	Percentage
Yes (Frequent difficulties)	9	43%
Sometimes (Occasional difficulties)	11	52%
No (No difficulty)	1	5%
Total	**21**	**100%**

This distribution demonstrates that learning difficulties are pervasive rather than isolated, as 95% of students reported either frequent or occasional challenges. The high proportion of “sometimes” responses suggests that students’ difficulties are topic-specific and may fluctuate across different aspects of web programming, such as understanding syntax, applying programming logic, or using development tools. Moreover, the minimal number of students who reported no difficulty indicates that current instructional practices may not yet sufficiently support diverse learning needs. These findings highlight the importance of adaptive and scaffolded learning strategies that provide targeted support according to students’ varying levels of difficulty.

This finding is in line with studies that emphasize the inherent challenges of learning programming. (Chou et al., 2021) found that many students tend to adopt surface learning approaches—such as rote memorization and copying code—when learning programming. These strategies often stem from a lack of conceptual understanding and low confidence in problem-solving, which contribute to the perception that programming is difficult. Similarly, (Papastergiou, 2009) found that students frequently experience anxiety and low self-efficacy when engaging with programming tasks, especially in web-based environments. These studies support the current result, in which nearly all students reported either consistent or occasional difficulties in learning web programming. This highlights the importance of adopting more supportive, concept-oriented instructional strategies to improve student engagement, confidence, and learning outcomes.

The interview on the fourth question, "what difficulties do you experience in learning web programming?" which was conducted on December 20, 2024 to 21 students who have been selected to get the results as The students reported a wide range of challenges in learning web programming, which can be grouped into several main categories:

1. Syntax and Coding Errors
   Many students found it difficult to handle errors caused by minor mistakes such as typos or incorrect commands. These small errors often result in code failure, leading to frustration
   - *"If there’s a typo, the code turns red."*
   - *"Errors occur when I don’t understand the commands."*
   - *"Typing mistakes often lead to problems."*
2. Understanding and Memorizing Syntax
   Some students expressed that understanding and memorizing programming syntax is challenging.
   - *"I find it a bit hard to understand and memorize syntax."*
   - *"There are programming languages that feel heavy and difficult."*
3. Logical Thinking and Output Discrepancies
   Students struggle with applying logic and face confusion when their output doesn’t match tutorials.
   - *"The output is different from the tutorial."*
   - *"The web gets updated and it creates new problems."*
   - *"It’s hard to create the right logic for the web to work properly."*
4. Tool and Environment Issues
   Technical issues with tools like VSCode or additional installations also contribute to difficulties.
   - *"VSCode and terminal are sometimes confusing."*
   - *"My laptop lacks what’s needed to run programming properly, and I need to install more software."*
5. Learning Resources and Guidance
   Several students stated that they need more explanation, clearer tutorials, or a mentor to help them learn.
   - *"I need someone to guide me while learning."*
   - *"Video tutorials are sometimes unclear or incomplete."*
6. Database Integration
   Some students mentioned specific challenges with databases, such as MongoDB.
   - *"I have difficulties with MongoDB."*
   - *"Database integration is hard to understand."*
7. Motivation and Frustration
   A few responses revealed emotional struggles, including stress and frustration due to persistent errors.
   - *"There are always errors, and it takes a long time to fix them—I feel like breaking my laptop."*
   - *"Sometimes I just can't focus and nothing stays in my head."*
   -

This analysis is based on a thematic interpretation of interview data, in which students’ responses were systematically coded and grouped into categories representing recurring learning difficulties. Initially, individual statements related to coding errors, unfamiliar commands, and typographical mistakes were coded as syntax-related difficulties. Responses describing confusion in using development environments, installing software, or operating

tools such as VSCode and terminals were categorized as tool and environment issues. Statements indicating the need for clearer explanations, direct assistance, or mentorship were coded under lack of instructional guidance, while expressions of frustration, stress, and loss of focus were grouped as emotional and motivational barriers.

These categories were then interpreted at a higher analytical level to identify broader patterns of learning barriers. Technical difficulties (syntax, tools, and databases) were interpreted as indicators of high cognitive load and limited procedural understanding, whereas emotional responses reflected the affective impact of repeated failure and insufficient learning support. By synthesizing these categories, the findings reveal that students' learning difficulties are not solely technical in nature but are intertwined with emotional and instructional factors. Consequently, the need for supportive, hands-on instruction and interactive learning materials emerges as a research-based implication rather than a speculative recommendation. Providing real-time guidance, simplified explanations, and structured troubleshooting support directly addresses the underlying barriers identified through this analytical process.

This finding is in line with (Chou et al., 2021), which found that students often adopt surface learning strategies—such as copying code or memorizing syntax—due to difficulties in understanding abstract programming concepts. These challenges are frequently accompanied by low confidence and anxiety, especially when students face persistent errors or inconsistent results in their coding tasks. Similarly, (Papastergiou, 2009) highlighted that students experience a lack of motivation and increased cognitive load when learning programming without sufficient instructional support. These studies support the current result, in which nearly all students reported experiencing either consistent or occasional difficulties in learning web programming. This underscores the urgent need for clearer guidance, interactive learning environments, and supportive feedback systems to help students overcome obstacles and improve their overall programming competence and confidence.

The interview on the last question, " According to you, which subject in Computer and Network Engineering (TKJ) is the most difficult?" which was conducted on December 20, 2024 to 21 students who have been selected to get the results as Students identified a variety of subjects within the Computer and Network Engineering (TKJ) program as particularly challenging. This finding is based on students' responses to the fifth interview question regarding the most difficult subjects within the Computer and Network Engineering (TKJ) program. Analysis of the interview data shows that a considerable number of students identified coding-related subjects—such as web development, programming, JavaScript, Python, and syntax-oriented tasks—as the most difficult areas. These responses were frequently accompanied by explanations related to difficulties in understanding programming logic, memorizing syntax, and maintaining consistent practice. For example, one student stated that "programming is hard because I have to remember many commands and the logic is confusing."

In addition, several students highlighted network-related topics, including TCP/IP, server administration, routing, and network security, as challenging subjects. These difficulties were commonly associated with the need for in-depth technical understanding, analytical reasoning, and accurate system configuration. One student explained that "network configuration is difficult because one small mistake can make everything not work." Furthermore, a smaller number of students mentioned microcontroller programming as particularly challenging, especially when it involved complex interactions between software and hardware components.

Although many students pointed to one or two specific subjects as the most difficult, some respondents indicated that nearly all TKJ subjects present learning challenges, depending on the topic and individual learning style. This variation suggests that learning difficulties within the TKJ curriculum span both software- and hardware-oriented domains. The diversity of responses indicates that students' challenges are not uniform but context-dependent, reinforcing the need for differentiated instructional approaches and targeted learning support strategies that address the specific demands of different technical subjects.

This finding is in line with the research by Chou, Tang, and Tsai (2021), which revealed that students often struggle with programming and technical subjects due to the abstract nature of the content, high cognitive load, and insufficient conceptual understanding. These challenges are particularly evident in areas such as coding, networking, and server administration, where students are required to master complex systems and logic. Similarly, Papastergiou (2009) emphasized the importance of instructional design and learning support in reducing anxiety and increasing student engagement in programming-related courses. These studies support the current result, in which students identified programming, TCP/IP networking, server administration, and microcontroller configuration as the most difficult subjects in the Computer and Network Engineering (TKJ) curriculum. This suggests the need for more interactive, guided, and differentiated learning strategies to help students navigate technical challenges and build deeper understanding and confidence in these areas.

4. CONCLUSION

Based on questionnaire and interview data collected from 21 students in the Computer and Network Engineering (TKJ) program, this study concludes that learning web programming poses substantial challenges for

vocational high school students. Questionnaire results indicate that all students perceived web programming as either very difficult (71%) or moderately difficult (29%), with none considering it an easy subject. Although most students (76%) reported a neutral level of enjoyment, only a small proportion found web programming highly enjoyable, suggesting limited intrinsic motivation despite recognizing its importance.

The qualitative analysis further reveals that students' learning difficulties are multifaceted and interconnected. Technical barriers—including syntax errors, difficulties in applying programming logic, and challenges in using development tools such as VSCode and terminal environments—were consistently reported. These technical issues were often accompanied by emotional responses, such as frustration, stress, and reduced confidence, particularly when students encountered repeated errors without sufficient instructional support. In addition, limited access to clear learning resources and the need for direct guidance were identified as factors that hinder independent learning.

Furthermore, students identified programming-related subjects and networking topics—such as TCP/IP and server administration—as the most difficult areas within the TKJ curriculum. These subjects were perceived as demanding high levels of cognitive processing, analytical thinking, and precise system configuration, indicating that learning challenges span both software- and hardware-oriented domains. The variation in students' responses also suggests that learning difficulties are context-dependent and influenced by individual learning styles and topic complexity.

Overall, the findings demonstrate that students' difficulties in learning web programming are not solely technical but are shaped by instructional, contextual, and affective factors. The fact that 95% of students experienced frequent or occasional difficulties highlights the need for more adaptive and scaffolded instructional approaches. Therefore, the implementation of interactive, hands-on, and student-centered learning strategies—such as guided practice, real-time feedback, contextualized projects, and structured troubleshooting support—is strongly recommended to enhance students' understanding, motivation, and confidence in mastering web programming competencies required by the vocational curriculum and industry demands.

ACKNOWLEDGEMENTS

This research was supported by RisetMu (Riset Muhammadiyah), whose funding and guidance significantly contributed to the completion of this study. We express our sincere gratitude for their support in advancing educational research within Muhammadiyah institutions.

REFERENCES

Almdahem, A. M. (2019). The perceptions of secondary school students regarding the learning of computer programming at Key Stage 4 in the revised curriculum in England : difficulties and prospects . *International Journal of Computer Science Education in Schools*, *7*(1), 1–16. https://doi.org/10.21585/ijcses.v7i1.147

Barron, B., & Chen, M. (2008). Teaching for meaningful learning: A review of research on inquiry-based and cooperative learning. *Powerful Learning: What We Know About Teaching for Understanding*, 11–70.

Chou, T. L., Tang, K. Y., & Tsai, C. C. (2021). A Phenomenographic Analysis of College Students' Conceptions of and Approaches to Programming Learning: Insights From a Comparison of Computer Science and Non-Computer Science Contexts. *Journal of Educational Computing Research*, *59*(7), 1370–1400. https://doi.org/10.1177/0735633121995950

Dirzyte, A., Vijaikis, A., Perminas, A., Rimasiute-Knabikiene, R., Kaminskis, L., & Zebrauskas, G. (2021). Computer programming e-learners' personality traits, self-reported cognitive abilities, and learning motivating factors. *Brain Sciences*, *11*(9), 1–24. https://doi.org/10.3390/brainsci11091205

Djenic, S., Krneta, R., & Mitic, J. (2011). Blended learning of programming in the internet age. *IEEE Transactions on Education*, *54*(2), 247–254. https://doi.org/10.1109/TE.2010.2050066

Gomes, A., & Mendes, A. J. (2007). Learning to program - difficulties and solutions | Academic Conference Paper. *In International Conference on Engineering Education–ICEE*, *7*(May), 3–7. https://www.researchgate.net/publication/228328491_Learning_to_program_-_difficulties_and_solutions

Govindaraju, V., Seruji, Z., & Yeng, S. K. (2023). Teaching Approaches and Methodologies: A Review of Post COVID-19. *Hong Kong Journal of Social Sciences*, *61*(61). https://doi.org/10.55463/hkjss.issn.1021-3619.61.22

Javier, B. S. (2017). Understanding their Voices from Within : Difficulties and Code Comprehension of Life-Long Novice Programmers. *International Journal of Arts, Sciences and Educatio*, *1*(1), 53–76.

López-Pimentel, J. C., Medina-Santiago, A., Alcaraz-Rivera, M., & Del-Valle-soto, C. (2021). Sustainable project-based learning methodology adaptable to technological advances for web programming. *Sustainability (Switzerland)*, *13*(15), 1–25. https://doi.org/10.3390/su13158482

Mbiada, K., Isong, B., & Lugayizi, F. (2023). A Comparative Study of Computer Programming Challenges of Computing and Non-Computing First-Year Students. *Indonesian Journal of Computer Science*, *12*(1), 1611–1625.

Muntholib, Hidayat, & Ariani, R. (2018). Computer Laboratorium Management To Increase The Information And Communication Technology Skills (ICT) Student Vocation High School In The Whole Province Of Jambi. *IOSR Journal of Research & Method in Education (IOSR-JRME)*, *8*(3), 66–69. https://doi.org/10.9790/7388-0803026669

Muslim, M. P., Hadi, N. T., Theresiawati, T., Seta, H. B., & Ernawati, I. E. (2024). School Curriculum Development Training with Collaborative Coding to Enhance Student Skills and Collaboration. *Dinamisia : Jurnal Pengabdian Kepada Masyarakat*, *8*(5), 1523–1532. https://doi.org/10.31849/dinamisia.v8i5.22612

Nugroho, W. A., Maryono, D., & Hatta, P. (2023). Analysis of Competency Curriculum Alignment in Web-Based Application Development on the Study Program of PTIK UNS with the Industrial World. *Journal of Informatics and Vocational Education (JOIVE)*, *6*(1), 4–8.

Papastergiou, M. (2009). Digital Game-Based Learning in high school Computer Science education: Impact on educational effectiveness and student motivation. *Computers and Education*, *52*(1), 1–12. https://doi.org/10.1016/j.compedu.2008.06.004

Park, T. H., & Wiedenbeck, S. (2011). Learning web development: Challenges at an earlier stage of computing education. *ICER'11 - Proceedings of the ACM SIGCSE 2011 International Computing Education Research Workshop*, 125–132. https://doi.org/10.1145/2016911.2016937

Piwek, P., Wermelinger, M., Laney, R., & Walker, R. (2019). Learning to program: From problems to code. *ACM International Conference Proceeding Series*. https://doi.org/10.1145/3294016.3294024

Robins, A., Rountree, J., Rountree, N., Robins, A., Rountree, J., & Rountree, N. (2016). Learning and Teaching Programming : A Review and Discussion Learning and Teaching Programming : A Review. *Computer Science Education*, *3408*(April), 37–41.

Rudewicz, J., & Sala, K. (2021). New professional competencies in the era of WEB 2 . 0 and 3 . 0 and the dissemination of ICT. *PRZEDSIĘBIORCZOŚĆ – EDUKACJA*, *17*(1). https://doi.org/10.24917/20833296.171.2

Santos, J. B., Martins, T. M., Nauane, A., Braga, E., Kamila, S., Campana, C. A., Leônidas, J., Wagner, A. F., Maslinkiewicz, A., Trindade, S., Pereira, C., Aguiar, S., & Araújo, J. S. (2024). *APPLICABILITY OF GAMIFICATION TO THE TEACHING AND LEARNING*. 5915–5925.

Santos, P. S. C., Araujo, L. G. J., & Bittencourt, R. A. (2018). A mapping study of computational thinking and programming in Brazilian K-12 Education. *Proceedings - Frontiers in Education Conference, FIE*, *2018-October*(October). https://doi.org/10.1109/FIE.2018.8658828

Sorongan, D., Mose, Y., & Berikang, R. A. (2022). Developing Virtual Web as Learning Media for Web Programming in SMK. *International Journal of Information Technology and Education*, *1*(2), 24–42. https://doi.org/10.62711/ijite.v1i2.35

Zhang, W., Guan, Y., & Hu, Z. (2024). The efficacy of project-based learning in enhancing computational thinking among students: A meta-analysis of 31 experiments and quasi-experiments. In *Education and Information Technologies* (Vol. 29, Issue 11). Springer US. https://doi.org/10.1007/s10639-023-12392-2