STEM-Integrated Web-Based Multimedia for Digital Literacy and Critical Thinking: An Islamic Perspective on Educational Innovation

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Abstract. Although digital media have become increasingly embedded in higher education, their availability does not necessarily translate into students' digital media literacy and critical thinking. At the same time, although STEM emphasizes on authentic problem-solving that may foster such competencies, how such principles can be embedded in web-based multimedia remains insufficiently understood. Therefore, this study aimed to develop a STEM-integrated Web-Based Multimedia (WBMM) product and assess its feasibility for use in digital media literacy learning. This study employed a Research and Development (R&D) methodology using the ADDIE model, consisting of the Analyze, Design, Development, Implementation, and Evaluation stages. The research participants involved subject-matter experts, media experts, and instructional design experts. Data were analyzed using descriptive statistics to evaluate the feasibility of the developed product. The findings revealed that the WBMM product obtained an average validation score of 97.50%, indicating that it was highly feasible. These findings suggest that integrating STEM principles into WBMM can establish a learning environment that promotes inquiry, authentic problem-solving, and evidence-based decision-making, which are consistent with the Islamic principle of *tabayyun*, the critical verification of information before accepting or disseminating it. This study offers a conceptual contribution that may serve as a reference for developing digital media literacy learning in higher education, including institutions with distinctive Islamic educational characteristics.

Keywords: STEM, Web-Based Multimedia, digital media literacy, critical thinking, higher education.

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U. Faruq et al. (eds.), *Proceedings of the 10th International Conference of Islamic Studies (ICONIS 2026) & 400th Anniversary of Shekh Yusuf Al-Makassari*, Advances in Social Science, Education and Humanities Research 1043,
https://doi.org/10.2991/978-94-6239-845-0_5

develops scientific and technological competencies but also equips learners with critical thinking, problem-solving, evidence-based decision-making, and literacy competencies needed to navigate the complexity of the digital media ecosystem [1]. This perspective is reinforced by Govender [2], who demonstrated that STEM and digital media literacy have a mutually reinforcing relationship. According to Govender, the core characteristics of STEM, including scientific inquiry, technology integration, engineering design, and mathematical reasoning, represent competencies that also underpin digital media literacy. Thus, the development of digital media literacy requires not only the ability to access and use digital media but also the capacity to critically evaluate information, verify its accuracy, solve digital problems systematically, and make decisions based on evidence.

This urgency has become increasingly relevant in the digital era, in which information flows across spatial and temporal boundaries, enabling individuals to access, consume, and produce information with unprecedented ease. However, alongside these opportunities, society is also confronted with the growing dissemination of fake news, disinformation, information manipulation, and various forms of digital privacy violations [3], [4]. These conditions require university students, who constitute one of the most active groups of digital media users as reported in Digital 2025 [5], to possess adequate digital media literacy and critical thinking skills in order to evaluate information objectively and make responsible decisions.

From an Islamic perspective, the ability to evaluate and verify information is closely related to the principle of *tabayyun*, which refers to the practice of carefully examining information before accepting, believing, or disseminating it. This principle is emphasized in Surah Al-Hujurat, verse 6, which highlights the importance of verifying the accuracy of information in order to prevent harm or injustice to others. Within the context of digital media, this principle has become increasingly relevant because information can be produced and disseminated rapidly without undergoing adequate verification.

Preliminary interviews with lecturers and students at Universitas Negeri Surabaya (UNESA) indicated that students' digital media literacy remains suboptimal. Students continue to experience difficulties in verifying information, evaluating source credibility, identifying information bias, and maintaining the security and privacy of digital data. These findings highlight the need for a learning instrument capable of strengthening digital media literacy competencies in a more systematic manner. Previous studies have reported similar phenomena. Erwin et al., [6] found that university students' digital literacy competencies do not develop automatically through the use of technology but require systematically designed learning experiences to enhance their ability to access, evaluate, and utilize digital information. Similarly, Smith and Storrs [7] reported that students continue to face difficulties in evaluating the credibility of information on social media, identifying misinformation, and understanding the ethical dimensions of digital media use in academic contexts. Meanwhile, Nkansah and Oldac [8] identified a knowledge gap in students' digital literacy, particularly in relation to information evaluation, digital security, privacy protection, and the use of technology for learning. Collectively, these findings suggest that the primary challenge of digital media literacy in higher education no longer lies merely in the ability to operate technology, but rather

in the capacity to think critically when evaluating, verifying, and using digital information responsibly. Consequently, there is a need for learning instruments that integrate the use of technology with systematic inquiry and problem-solving activities.

To enhance digital media literacy, including critical thinking skills, the application of STEM (Science, Technology, Engineering, and Mathematics) principles represents a promising approach, consistent with Govender's [2] argument that STEM and digital media literacy mutually reinforce one another. One learning environment that offers strong potential for implementing these principles is Web-Based Multimedia (WBMM). Mackey and Ho [9] define WBMM as the integration of web technologies with various forms of multimedia, including text, images, audio, video, animation, and interactive simulations, thereby creating richer, more contextualized, and student-centered learning experiences. By integrating STEM principles into a WBMM environment, students can be encouraged to engage in scientific thinking (science), utilize technology effectively (technology), design and develop solutions to problems (engineering), and apply logical and quantitative reasoning (mathematics) in the decision-making process.

Such a learning process is expected not only to improve digital media literacy in terms of accessing, analyzing, evaluating, creating, and responsibly using digital information, but also to strengthen critical thinking skills by engaging students in systematic processes of analysis, evaluation, reflection, and evidence-based problem-solving. In Islamic thought, these principles are consistent with *tabayyun*, understood as the careful clarification and verification of information or phenomena. This principle is reflected in Surah Al-Hujurat, verse 6, which emphasizes the importance of examining the truthfulness of information before acting upon it, in order to avoid causing harm to others due to ignorance or misinformation. In the context of digital media, *tabayyun* can therefore serve as an ethical foundation for critically assessing information before accepting, sharing, or using it.

The mutually reinforcing relationship between digital media literacy and STEM principles, together with the limited body of research investigating the integration of STEM into efforts to enhance digital media literacy, provides the rationale for the present study. This study seeks to address this gap by integrating STEM principles into a Web-Based Multimedia (WBMM) environment. The integration is expected to produce a feasible learning instrument capable of enhancing students' digital media literacy and critical thinking skills. Within the context of higher education grounded in Islamic values, this integration also provides an opportunity to position the principle of *tabayyun* as an ethical foundation for receiving, evaluating, and responsibly using digital information. Accordingly, this study is expected to provide a reference for the development of digital media literacy websites, which remain relatively limited, while also enriching scholarly discussions on the application of STEM beyond the conventional domain of science education.

2 Method

This study employed a Research and Development (R&D) approach using the ADDIE development model (Analyze, Design, Development, Implementation, and Evaluation) developed by Branch [10]. The ADDIE model was selected because it provides a systematic procedure for designing, developing, validating, implementing, and evaluating learning products. In this study, the ADDIE model was employed to develop a Web-Based Multimedia (WBMM) product integrated with STEM principles. Figure 1 illustrates the ADDIE process used in the development of the STEM-integrated WBMM.

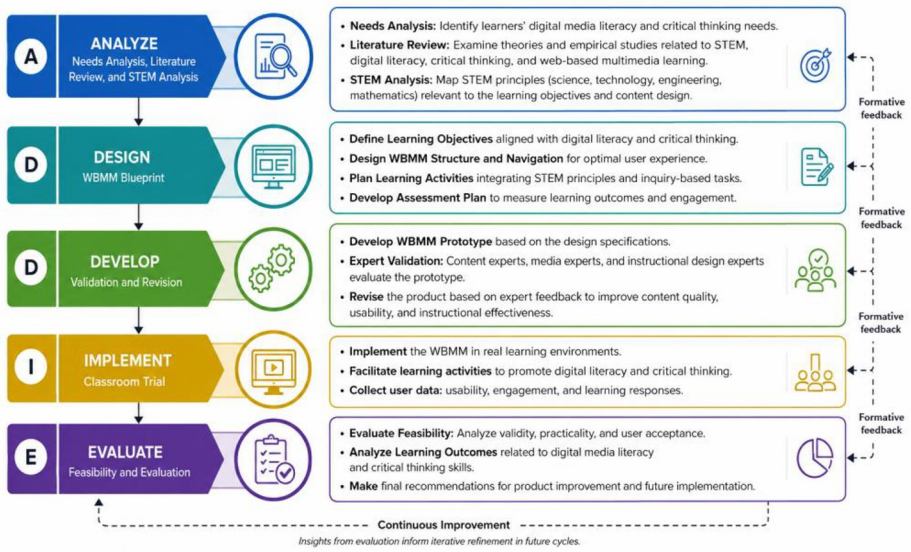


Fig. 1. ADDIE Stages in Designing the WBMM

During the Analyze stage, curriculum analysis, student characteristics analysis, learning needs analysis, and a literature review concerning STEM, Web-Based Multimedia (WBMM), digital media literacy, and critical thinking skills were conducted. This stage aimed to identify learning needs and establish the conceptual foundation for the development of the WBMM product. The Design stage focused on designing the WBMM by integrating STEM principles into the website's features, content, learning activities, and interface, thereby providing a blueprint for system development in the subsequent stage. During the Development stage, the WBMM was developed according to the established design and validated by subject-matter, media, and instructional design experts. The validation results served as the basis for revising the product to ensure that the website met the required feasibility criteria before implementation.

The Implementation stage involved the application of the WBMM in the Digital Literacy course within the Educational Technology Study Program at Universitas

Negeri Surabaya. The Evaluation stage was conducted both formatively and summatively. Formative evaluation was carried out through revisions based on feedback from the expert validators, whereas summative evaluation aimed to assess the quality of the WBMM in terms of its feasibility.

The research participants consisted of expert validators from the Educational Technology Study Program at Universitas Negeri Surabaya. The validators were purposively selected based on their respective areas of expertise, namely learning content, instructional media, and instructional design, with one expert representing each area. Data were collected using a validation questionnaire to evaluate the feasibility of the WBMM. The research instruments underwent content validation by experts before being used in the implementation stage. Data were analyzed using Wiersma's [11] percentage of achievement formula, as follows:

$$p = \frac{f}{N} \times 100\%$$

Note:
f=the frequency for which the percentage is being calculated
N=the total frequency or number of individuals
p=percentage value

3 Result and Discussion

3.1 STEM-Integrated Web-based Multimedia

Web-Based Multimedia (WBMM) was developed by integrating the principles of Science, Technology, Engineering, and Mathematics (STEM) into the website design. This integration was reflected in the learning materials, feature design, content, learning activities, and evaluation mechanisms that support the achievement of the intended learning objectives. Each STEM principle was translated into distinct characteristics and functions according to its role within the web-based learning environment. The integration aimed to create a web-based learning environment that not only presents learning materials digitally but also facilitates students in developing critical thinking skills and digital media literacy through interactive learning experiences. The implementation of STEM principles across the features of the WBMM, along with their corresponding learning objectives, is presented in Table 1.

Table 1. Implementation of STEM Principles in WBMM

STEM Principle	WBMM	Learning Objective
Science	Learning materials related to digital media literacy, including e-commerce and digital payments, legal regulations and compliance, the Internet of Things (IoT)	To facilitate students in observing, exploring, analyzing, and evaluating digital information based on facts and evidence, thereby enhancing their digital media literacy and critical thinking skills.

STEM Principle	WBMM	Learning Objective
	and Artificial Intelligence (AI), Google tools, the Electronic Information and Transactions Law (UU ITE), and data protection.	
Technology	A multimedia-based website equipped with features that support the learning process, including a user dashboard, login system, learning material menus, videos, online quizzes, web navigation, and a learning materials repository.	To utilize web and multimedia technologies as an interactive, flexible, and accessible learning environment that supports both independent and collaborative learning.
Engineering	Assignments, quizzes, task submission, learning management features, and problem-solving activities.	To facilitate students in designing and developing solutions and strategies for addressing digital literacy problems through task completion and problem-based activities supported by the WBMM.
Mathematics	Activities involving the processing and interpretation of information obtained from the website to formulate conclusions regarding a particular problem.	To facilitate students in connecting, analyzing, and interpreting various sources of information obtained from the web in order to draw evidence-based conclusions regarding digital media literacy issues.

The implementation of the Science principle in the WBMM was realized through the provision of learning materials related to digital media literacy, including e-commerce and digital payments, legal regulations and compliance, the Internet of Things (IoT) and Artificial Intelligence (AI), Google tools, the Electronic Information and Transactions Law (UU ITE), and data protection. These materials can be accessed through the course page and the learning materials menu such as presented in Figure 2.

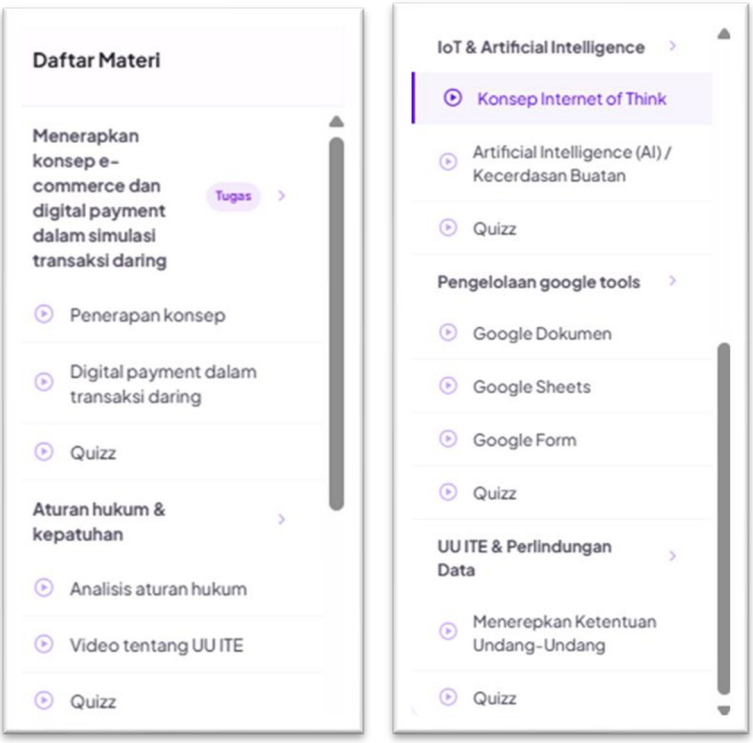


Fig. 2. List of Learning Materials in the WBMM

The appearance of the learning materials panel, based on Figure 2, displays structured learning content. The availability of these materials encourages students to study the concepts of digital media literacy, explore various sources of information, and analyze the credibility of information before drawing conclusions. Thus, students do not merely receive information passively but also develop critical thinking skills through an evidence-based inquiry process, which represents a key characteristic of the Science principle. As explained by Carmona [12], the Science principle is reflected in scientific thinking processes that involve systematic stages of inquiry and the use of scientific learning resources before reaching a conclusion. This evidence-based inquiry process also reflects the Islamic principle of *tabayyun*, which emphasizes verifying information before accepting or disseminating it. In the context of digital media literacy, *tabayyun* provides an ethical foundation for students to examine information sources, evaluate credibility, and draw conclusions based on verified evidence. Thus, the integration of *tabayyun* complements the Science principle in fostering critical and responsible engagement with digital information.

The implementation of the Technology principle in the WBMM was realized through the use of programming languages and website development software, the provision of features that support the learning process, and the presentation of learning

materials through multimedia. The WBMM was developed using the PHP programming language with the Laravel framework, while Figma was used as the primary software for designing the website interface and prototype. These technological components enabled the development of a multimedia-rich and interactive learning environment that integrates various digital resources and learning features to support students' access to learning materials and their engagement in the learning process.

The WBMM provides a range of learning features to support the learning process. For more detail, such information can be seen in Figure 3.

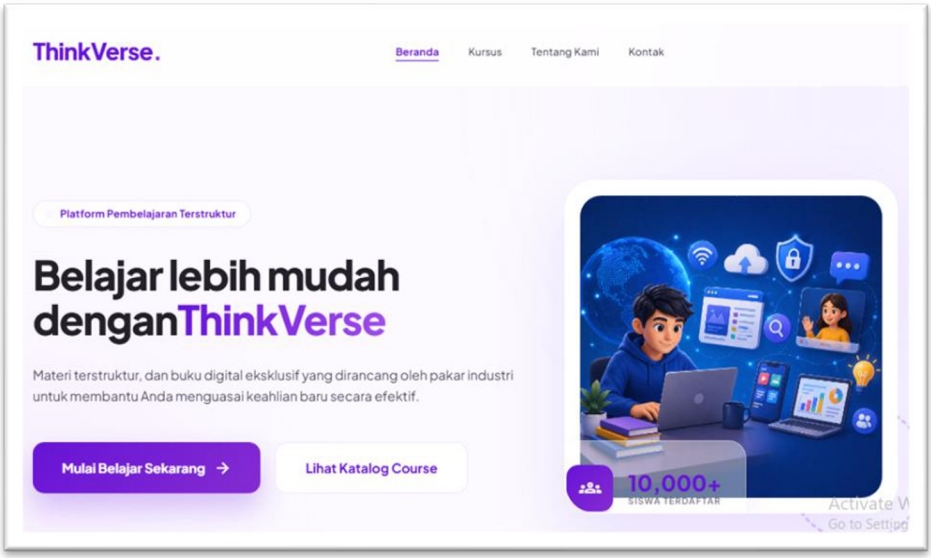


Fig. 3. WBMM Learning Materials Menu

It can be seen from Figure 3 that The WBMM provides a user dashboard, login system, learning materials menu, instructional videos, online quizzes, web navigation, and a learning materials repository. These features are integrated to support the overall learning process and facilitate students' access to and engagement with learning resources.

Learning materials in the WBMM are presented through multimedia, as illustrated in Figure 4, which shows the "UU ITE & Digital Literacy" material delivered in both text and video formats.

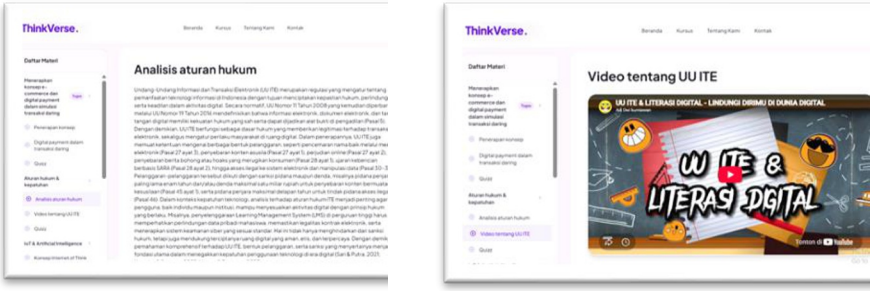


Fig. 4. The "UU ITE & Digital Literacy" material presented in text and video formats

The integration of these features, in Figure 4, enables students to access learning resources flexibly without limitations of time and place, enhances interaction between students, the learning materials, and the system, and supports both independent and collaborative learning. Thus, the website functions not merely as a medium for delivering learning content but also as a digital learning environment that utilizes web and multimedia technologies to enhance the effectiveness of the learning process. This is consistent with the view proposed by Mackey and Ho [9] and aligns with Mayer's [13] Cognitive Theory of Multimedia Learning (CTML).

Figure 5 presents the assignment feature in the WBMM, which provides students with opportunities to complete learning tasks systematically based on the materials, references, and multimedia resources they have previously studied.

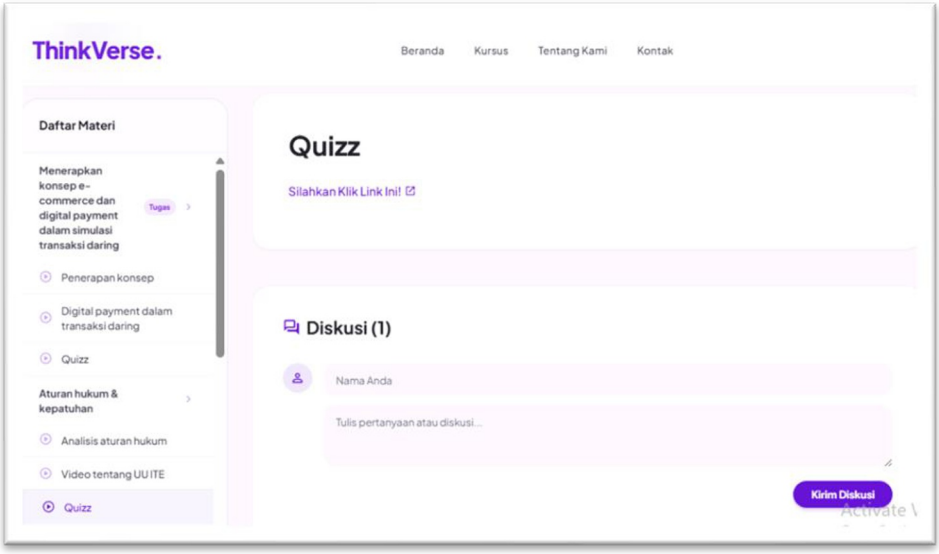


Fig. 5. Assignment Features in the WBMM

The implementation of the Engineering principle in the WBMM was realized through learning activities that required students to analyze and solve authentic problems in the field of digital literacy by utilizing various learning resources available on the website. Through these activities, students are encouraged to identify problems, formulate alternative solutions, and gather relevant reference sources. Thus, the implementation of the Engineering principle in the WBMM focuses on the process of designing strategies to address digital literacy problems through the use of web technology as a learning environment. This is consistent with Linh and Huong [14], who emphasized that engineering within STEM is fundamentally positioned as an iterative and systematic decision-making process for solving problems rather than merely as an activity focused on producing physical products.

The implementation of the Mathematic principle in the WBMM was realized through activities involving the processing, comparison, and interpretation of data and information obtained by students from various digital sources to generate logical conclusions related to digital media literacy issues. These activities were integrated with the Engineering principle, particularly through assignments and problem-solving tasks, in which students used the data and evidence they obtained to analyze problems, compare alternative solutions, and make appropriate decisions. Therefore, the Mathematics principle not only supports the development of students' ability to process quantitative information but also encourages them to evaluate evidence, connect diverse sources of information, draw rational conclusions, and strengthen their critical thinking skills in addressing digital media literacy problems. These findings are consistent with Sehrawat [15], who argued that mathematics is inherently logical and organized, requiring students to engage in systematic reasoning, problem-solving, and abstract thinking.

Overall, the integration of STEM principles into the WBMM demonstrates that the website functions not merely as a medium for delivering learning materials but also as a digital learning environment that integrates scientific inquiry, the effective use of technology, systematic problem-solving, and information processing. Through this integration, the WBMM supports the development of students' problem-solving abilities while contributing to the enhancement of their digital media literacy and critical thinking skills. From an Islamic perspective, the integration of STEM principles into WBMM positions *tabayyun* as an ethical dimension of digital media literacy. While STEM promotes systematic inquiry, problem-solving, and evidence-based reasoning, *tabayyun* provides an ethical foundation for critically evaluating and responsibly using digital information. Thus, the integration of STEM and *tabayyun* strengthens the conceptual contribution of WBMM to digital media literacy learning in higher education, particularly in contexts that integrate technological competencies with Islamic values.

3.2 WBMM Feasibility

The feasibility of the WBMM was evaluated through an expert validation process to ensure that the website met the required quality standards before being implemented in the learning process. The validation of the WBMM involved three expert validators. A summary of the expert validation results is presented in Table 2, showing that all three

validators, representing the areas of learning content, instructional media, and instructional design, rated the WBMM as highly feasible, with an overall average score of 97.50%. These results indicate that the WBMM met the required standards in terms of content substance, media quality, and instructional design. The high validation scores further suggest that the integration of STEM principles into the WBMM was systematically and consistently designed, thereby supporting its potential implementation in digital literacy learning.

Table 2. Website Feasibility Results Based on Validation by Subject-Matter, Media, and Instructional Design Experts

No.	Validator	Aspect Assessed	Mean	Category
1	Subject-Matter Expert	Alignment of the learning materials with the learning objectives and website characteristics	100,00	Highly Feasible
2	Subject-Matter Expert	Organization and systematic presentation of the learning materials on the website	100,00	Highly Feasible
3	Subject-Matter Expert	Clarity of concepts and presentation of the learning materials	100,00	Highly Feasible
4	Subject-Matter Expert	Contextual relevance of the learning materials	97,50	Highly Feasible
5	Subject-Matter Expert	Evaluation and alignment of the questions/quizzes provided on the website	95,00	Highly Feasible
6	Subject-Matter Expert	Readability of the learning materials	97,50	Highly Feasible
	Mean Score of Subject-Matter Expert Validation		**98,75**	**Highly Feasible**
7	Media Expert	Design of the website homepage	100,00	Highly Feasible
8	Media Expert	Quality and readability of text on the website	100,00	Highly Feasible
9	Media Expert	Layout and interface presentation	100,00	Highly Feasible
10	Media Expert	Language use on the website	97,50	Highly Feasible
	Mean Score of Media Expert Validation		**99,38**	**Highly Feasible**
11	Instructional Design Expert	Website usability	95,00	Highly Feasible
12	Instructional Design Expert	Language and linguistic appropriateness	93,75	Highly Feasible
	Mean Score of Instructional		**94,38**	**Highly Feasible**

No.	Validator	Aspect Assessed	Mean	Category
	Design Expert Validation			
	Overall Mean Score of Website Feasibility		**97,50**	**Highly Feasible**

The feasibility results further support Govender's [2] view that STEM and digital media literacy have a mutually reinforcing relationship. The integration of STEM principles into the website's features, content, learning activities, and evaluation mechanisms provides a foundation for students to develop their ability to evaluate information, solve problems, and make evidence-based decisions. This study extends this perspective by demonstrating that the relationship between STEM and digital media literacy is not merely conceptual but can also be operationalized through the development of a WBMM product.

The expert validation results indicate that the developed WBMM learning product met the requirements for content quality, media quality, and instructional design and was therefore considered highly valid for use in learning. The characteristics of the product were designed by integrating STEM principles into the features, content, learning activities, and evaluation mechanisms of the WBMM. Accordingly, digital technology functions not merely as a medium for delivering information but also as a means of facilitating exploration, analysis, problem-solving, and evidence-based reflection. This design is consistent with the findings of Rizaldi et al., [16], who explained relationship between STEM integration and the development of students' digital literacy and twenty-first-century skills. Such a learning approach is also consistent with student-centered learning environments that encourage the gradual construction of knowledge. These characteristics support the view of Furbani et al., [17] that digital literacy and critical thinking are essential competencies in the 4.0 Era and should be facilitated through learning designs that are relevant to advances in digital technology.

The developed WBMM product was also designed to provide various features that support digital information evaluation, the construction of evidence-based arguments, collaboration, and learning reflection. These characteristics are consistent with Zou'bi [18], who emphasized that the development of media and information literacy requires learning environments that foster critical thinking through information analysis and evaluation activities. Similarly, Pyshchyk [19] explained that digital technologies can make an optimal contribution to the development of media literacy when supported by systematically designed learning strategies.

The primary advantage of the developed WBMM compared with previous developments lies in the integration of two key components: STEM principles as the conceptual foundation and Web-Based Multimedia (WBMM) as the digital learning environment. Unlike many web-based learning products that primarily focus on providing digital media, the product developed in this study integrates interactive multimedia, inquiry activities, digital information exploration, and authentic problem-solving within a coherent learning design. This integration results in a product that is not only oriented toward

the use of technology but also grounded in pedagogical principles that support the development of twenty-first-century competencies.

The findings of this study provide a theoretical contribution by strengthening the argument that STEM can serve as a conceptual foundation for developing web- and multimedia-based learning products that support digital media literacy in higher education. From a practical perspective, the WBMM offers an alternative design for Web-Based Multimedia by integrating digital technology, interactive multimedia, and STEM principles within a systematic framework. Based on the expert validation results, the developed product demonstrated a very high level of validity and is therefore suitable to serve as a basis for subsequent implementation and further effectiveness testing in future studies.

4 Conclusion

This study successfully developed a learning instrument in the form of a WBMM-STEM website that integrates the principles of Science, Technology, Engineering, and Mathematics (STEM) into its features, content, learning activities, and evaluation mechanisms as a web- and multimedia-based learning product to support digital media literacy learning in higher education. Expert validation results indicated that the developed WBMM website obtained an average validity score of 97.50%, categorized as highly valid. The product therefore met the required standards in terms of content, media, and instructional design and was considered suitable for use in digital literacy learning.

This study demonstrates that integrating STEM principles into Web-Based Multimedia Learning (WBMM) environment to provide a structured learning design incorporating inquiry, problem-solving, and evidence-based reasoning, which are conceptually relevant to digital media literacy and critical thinking. The developed WBMM website is expected to serve as a reference for lecturers and instructional developers in designing digital learning environments that are more systematic, interactive, and oriented toward twenty-first-century competencies. Future research is recommended to implement this framework across diverse learning contexts to examine its practicality, effectiveness, and impact on the development of students' digital media literacy and critical thinking skills.

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