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Development of STEAM Approach Website-based Learning on Carrd Platform to Improve Students' Learning Outcomes

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Abstract

The utilization of websites as educational media has become increasingly prominent due to their accessibility and user-friendliness. One innovative approach to developing website-based learning tools involves the use of the Carrd platform. This study aims to examine the validity, practicality, and effectiveness of a website-based learning on the Carrd platform using the STEAM (Science, Technology, English, Arts, and Mathematics) approach and its impact on improving student learning outcomes. The study employs a research and development (R&D) methodology, incorporating the ADDIE model (analysis, design, development, implementation, and evaluation). Conducted at SMA Kesatrian 1 Semarang, the research population comprised eleventh-grade students, with class XI-1 as the experimental group and XI-2 as the control group. The findings of the study are as follows: (1) The website-based learning was highly valid by both material experts and media experts, with approval rates of 100% and 92.5%. (2) The website-based learning was considered highly practical, eliciting a very positive response from biology teachers (96%) and students (90.28%). (3) The website-based learning is effectively used and demonstrated a positive influence on improving student learning outcomes, with the experimental class's achievements rate of 85%. The findings of this research are anticipated to promote the utilization of technology within the educational landscape, thereby facilitating more flexible access to learning materials as a means of enhancing collaboration between teachers and students. Future developments in this research could be achieved by incorporating interactive features and integrating additional technologies, such as artificial intelligence (AI) and augmented reality (AR), to enrich the learning experience.

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INTRODUCTION)

The development of learning media must be meticulously designed to enhance students' learning motivation, academic achievement, and teachers' competency (Akrim, 2018; Kadarisman *et al.*, 2022). Currently, digital learning media are available in various formats, one of which is website-based learning. Websites serve as learning media due to their accessibility and ease of use. The development of educational websites is motivated by the limitations of existing learning platforms, which are often ineffective, as well as the underutilization of websites in learning settings by educators (Astuti *et al.*, 2020). One of the web-based learning media platforms that has been developed is Carrd.

Carrd is one of the platforms available for developing educational websites; however, its application in biology education remains relatively uncommon. The utilization of Carrd as learning media has been shown to yield positive outcomes (Muthmainnah, 2022). A study by Yuniar *et al.* (2023) demonstrated that Carrd effectively enhanced adolescent girls' knowledge and attitudes regarding menstruation. The developed Carrd-based learning media was deemed feasible and received positive feedback from students due to its practical, engaging, and communicative design (Muthmainnah, 2022; Suhendra & Sobara, 2023; Aeni *et al.*, 2022).

In relation to 21st century competencies, the development of Carrd as a learning medium has been validated as both viable and effective in moderately enhancing students' motivation and overall learning quality. However, existing websites with Carrd-based media remain limited in terms of visual presentation and content depth (Raudah *et al.*, 2021). Therefore, this study aims to develop a more interactive and innovative website-based learning to further support the learning process. One of the key innovations introduced in this study is the integration of the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach.

The STEAM approach is an interdisciplinary learning framework that integrates five key domains to enhance students' competencies in addressing 21st-century challenges. This approach fosters student engagement in the learning process while equipping them with essential problem-solving skills applicable to both everyday life and professional environments (Halim & Roshayanti, 2021; Mabsutsah & Yushardi, 2022). By integrating these domains, STEAM provides a cohesive link between real-world challenges and problem-based learning, ensuring that students develop the necessary skills to navigate modern societal and professional demands (Torlakson, 2014).

The implementation of STEAM-based learning resources and learning media has been widely explored through the development of modules, e-modules, and student worksheets (LKPD). Research findings indicate that such implementations not only establish a foundational framework for STEAM-based module development but also contribute to improved learning outcomes and enhance students' scientific process skills (Utomo *et al.,* 2020; Patresia *et al.*, 2020; Mabsutsah & Yushardi, 2022). The integration of the STEAM approach into website-based learning platforms has also been examined, with studies utilizing other platforms demonstrating that STEAM-based websites are valid, practical, and effective, as evidenced by significant improvements in students' pretest and posttest scores (Hendriawan *et al.*, 2023). Furthermore, the STEAM approach has been successfully applied in biology education, particularly in topics such as the circulatory system, demonstrating its potential to enhance students' conceptual understanding and engagement in scientific learning.

The circulatory system is a core topic in the Grade XI high school biology curriculum for the first semester. According to the latest learning achievement standards, students are expected to analyze the interconnections between organ systems in response to both internal and external stimuli. However, studies have shown that students frequently experience misconceptions regarding the circulatory system, with one of the primary contributing factors being the lack of adequate learning resources (Khairaty *et al.*, 2018; Nainggolan, 2017). Therefore, it is essential to develop supplementary learning media and learning resources, one of which is website-based learning. Research indicates that websites can enhance students' learning outcomes, making them a viable alternative to traditional learning materials (Persada, 2017).

Furthermore, improved learning outcomes serve as a key indicator of the effectiveness of the learning process (Dewi *et al.*, 2015).

Given these challenges, the development of a website-based learning on a Carrd platform using STEAM approach is crucial to improving student learning outcomes. It is expected that such a website will have a significant impact on enhancing students' understanding of the material. Additionally, all information presented on the website will be sourced from accredited books and peer-reviewed journals, ensuring its accuracy and reliability.

RESEARCH METHOD

This study employs a research and development (R&D) approach utilizing the ADDIE development model, which consists of five stages: analysis, design, development, implementation, and evaluation. The research was conducted at SMA Kesatrian 1 Semarang during the odd semester of the 2024/2025 academic year.

1. Analyze

The analysis stage consisted of two main activities. First, learning outcome analysis, was conducted based on the learning outcomes for Phase F. The selected topic was the circulatory system, with the expected learning outcome that, by the end of Phase F, students should be able to analyze the interrelationships among organ systems in the human body in responding to internal and external stimuli. Second, needs analysis was conducted to identify the availability and utilization of teaching materials and instructional media. Data were collected through interviews with a biology teacher at SMA Kesatrian 1 Semarang. In addition, written questionnaires were administered to the biology teacher and students at the same school to obtain information regarding their needs and perspectives on the existing learning resources and instructional media.

2. Design

The design stage focused on planning the instructional media to be developed. This stage began with collecting relevant information and research findings about the human circulatory system. The information was obtained from relevant textbooks and scientific articles. Subsequently, the collected information was organized and integrated into a website. The website was developed using the Carrd platform, which served as the primary tool for designing and presenting the learning materials in an integrated and accessible format.

3. Development

The development stage involved several activities, including conducting a preliminary test of the assessment items to examine their validity and practicality. Product validation was carried out by subject matter experts and media experts to assess the content quality and media feasibility of the developed website. Furthermore, a practicality assessment was conducted by collecting responses from biology teachers and students to determine the ease of use and suitability of the instructional media for the learning process.

4. Implementation

The implementation stage involved applying the developed instructional media through small-scale and large-scale trials. The small-scale trial was conducted involving students from class XII-4. This trial also included the testing of the research instruments to examine their validity before being used in the larger-scale implementation. The large-scale implementation involved two groups receiving different instructional treatments: a control group and an experimental group. The control group received conventional instruction without using the developed instructional media, whereas the experimental group received instruction using the Carrd-based website. Both groups were administered pretests and posttests to measure students' learning outcomes before and after the instructional intervention.

The study involved two classes at SMA Kesatrian 1 Semarang, namely class XI-1 as the experimental

group and class XI-2 as the control group. The experimental group participated in learning activities supported by the Carrd-based instructional website, while the control group received conventional instruction using PowerPoint presentations and lecture-based teaching methods.

5. Evaluation

The evaluation stage was integrated throughout the four preceding stages of the ADDIE model: analysis, design, development, and implementation. This ongoing evaluation process is referred to as formative evaluation, which aims to identify shortcomings and areas for improvement at each stage of the development process. The findings from these evaluations were used as the basis for revising and improving the instructional media to ensure that the final product met the expected standards of quality, feasibility, and practicality.

RESULTS AND DISCUSSION

In relation to the research questions and objectives, the developed website-based learning is evaluated based on three key criteria: (1) validity, (2) practicality, and (3) effectiveness.

Validity

The validity of the product was determined through an expert validation process involving two validators: a subject matter expert and a media expert. The content validity of the website was assessed based on several aspects, including content feasibility, linguistic appropriateness, and presentation quality. The validation result from the subject matter expert was 100%. This score falls under the category of "highly valid." According to the validation criteria table, a website-based learning is considered viable if the evaluation score for assessed aspects is at least 61% (Arikunto, 2013). Based on these findings, it can be concluded that the website is appropriate for use in terms of content feasibility, language quality, and presentation. Additionally, feedback and suggested revisions from the validators have been incorporated to enhance the quality of the website before its final implementation. The media validity of the website was assessed based on two key aspects: graphical design and programming quality. The validation result was 92.5%. This score falls under the category of "highly valid." These findings indicate that, in terms of media quality—particularly in graphical design and programming—the website meets the expected quality standards to support the learning process.

The overall evaluation conducted by both the subject matter expert and the media expert categorizes the website-based learning as a highly effective learning medium. This aligns with findings from previous studies on the use of website-based learning (Astuti *et al.*, 2020; Sadikin *et al.*, 2020; Syahmina *et al.*, 2023; Puspa, 2022; Leksono *et al.*, 2021; Januarisman & Ghufron, 2016). Furthermore, the website development process was appropriately integrated with a learning approach—specifically, the STEAM approach (Hendriawan *et al.*, 2023). The STEAM approach embedded in the website follows a silo-based implementation model, which allows for the separation of each STEAM component (Roberts & Cantu, 2012). More detailed illustration of the STEAM approach applied within the website is presented in Table 1.

Practicality

The practicality of the website was assessed using teacher and student response questionnaires. The teacher response results yielded an average score of 96%, which falls under the category of "highly practical." Teachers involved in the evaluation provided highly positive feedback regarding the website's ease of use. Additionally, the website was deemed highly effective in supporting classroom learning, as it contributed to students' knowledge enhancement (Yuniar *et al.*, 2023). Teachers also found that the website's features—such as practice questions, interactive quizzes, and easily accessible learning materials—helped students better understand the concepts being taught.

Table 1. STEAM approach applied within the website.

STEAM Components	Implementation within the Website
Science	The website provides scientific learning resources on the human circulatory system, including learning materials, instructional videos, practice questions, assessments, and supplementary resources such as scientific articles and learning modules.
Technology	The website integrates technology into the learning process by enabling students to access learning materials and interactive learning components through internet-connected devices. This integration also supports the development of students' digital literacy.
Engineering	The engineering component is incorporated through student-centered learning activities, including worksheets (LKPD) and virtual laboratory simulations. These activities provide students with opportunities to engage in practical learning experiences and apply their knowledge through simulated investigations.
Arts	The arts component is reflected in the visualization of students' understanding of various types of blood cells. Students are also encouraged to express their understanding creatively through an infographic design task provided as the final assignment.
Mathematics	The mathematics component is integrated by encouraging students to interpret and analyze quantitative information, particularly normal blood cell counts and blood pressure values. These data are presented in tables on the website to support students' mathematical reasoning and interpretation of biological information.

The student response results for assessing the practicality of the learning website yielded an average score of 90.28%, evaluated based on three aspects: presentation, usability, and learning motivation. The presentation aspect includes website functionality, the arrangement of components, user guidelines, and practice questions. This aspect received the highest percentage, indicating that students provided highly positive feedback on the content presentation of the website. The website's visually appealing design, well-structured and sequential learning materials, and interactive features contribute to increased student interest, facilitate a smoother learning flow, and enhance student engagement. These factors have the potential to generate a significant number of positive responses from students (Kamilah *et al.*, 2023; Yunus *et al.*, 2023; Choirunnisa & Widiyanti, 2023).

The usability aspect refers to the ease of using the learning website. One factor that may contribute to a lower percentage in this aspect is the user interface (UI) design, which may not yet be fully intuitive, particularly for students with varying levels of technological proficiency. Previous research indicates that an intuitive UI design can enhance user comfort when utilizing e-learning platforms, especially websites (Geasela *et al.*, 2018). The learning motivation aspect is assessed based on students' motivation to learn and their curiosity. Students with high curiosity tend to seek new information and knowledge continuously, which encourages them to study more diligently (Alfonso, 2021). The high percentage of motivation observed in this study may be attributed to students' first-time experience with a new learning medium, as the use of learning websites was a novel approach for them. The excitement and curiosity toward new

technologies encourage students to explore further, which is a crucial factor in website-based learning (Barokah *et al.*, 2024).

Effectiveness

The effectiveness of the learning website was evaluated based on students' learning outcomes in both the experimental and control classes. In this study, a comparison of learning outcomes between the experimental class, which used the website-based learning approach, and the control class, which followed traditional teaching methods, revealed a difference as shown in Table 2.

Table 2. Achievement rate of the Experimental and Control Classes

Data	Eksperiment class		Control class	
	Pretest	*Posttest*	*Pretest*	*Posttest*
Minimum Competency Standard	75	75	75	75
Number of Students Who Passed	0	28	0	25
Number of Students Who Did Not Pass	33	5	32	7
Mean	28,18	80,15	24,22	78,59
Achievements rate (%)	0%	85%	0%	78%

Based on the analysis of pretest and posttest data, the average learning outcomes of students in the experimental class were higher than those in the control class. During the pretest, before students participated in the learning process, both classes exhibited relatively similar results, with no students meeting the minimum competency standar. This indicates that students in both groups had comparable prior knowledge (Adri, 2020). However, after undergoing the learning treatment for a certain period, the posttest results demonstrated that the experimental class, which utilized the learning website, showed a significantly greater score improvement than the control class. The increase in learning outcomes is also associated with the implementation of the STEAM approach, as it fosters greater student engagement in learning activities (Mabsutsah & Yushardi, 2022; Makkasau *et al.*, 2023). The integration of STEAM within the learning website enables students to develop multiple competencies aligned with the STEAM framework, thereby enhancing their readiness to face 21st-century learning challenges (Halim & Roshayanti, 2021).

Conversely, the control class did not meet the predetermined achievements rate, suggesting that despite an improvement in posttest scores, the increase was not substantial enough to achieve the expected target. Website-based learning media has been proven to offer several advantages, such as more interactive content delivery, access to diverse learning resources, and the ability to support independent and flexible learning, ultimately enhancing learning outcomes (Astuti *et al.*, 2020; Puspa, 2022; Febriansyah, 2020; Januarisman & Ghufron, 2016). However, in the control class, conventional teaching methods were employed, resulting in relatively lower score improvements than in the experimental class. This finding suggests that traditional learning methods may be less effective in optimizing learning outcomes compared to website-based learning media, primarily due to a lack of interactivity (Arlianti, 2018).

The experimental class demonstrated classical completeness; however, the difference between the experimental and control classes was relatively modest. Several factors contributed to this outcome. First, the STEAM approach promotes deeper and more challenging learning experiences, which may not be immediately adaptable for all students within a short period. This aligns with findings by Ramdayani *et al.* (2023), who observed that while the STEAM model effectively enhances students' critical thinking skills, these improvements occur gradually over three learning cycles, indicating that students require time to adjust to this pedagogical approach.

Another influencing factor is students' interest in using digital media for learning. Students with low interest in technology or web-based learning tend to lack motivation to explore material independently, even when interactive and engaging media are employed (Kristiawan & Kumalasari, 2023). Additionally, students' familiarity with digital media for educational purposes plays a significant role. As noted by Pertiwi & Sutama (2020), students unaccustomed to online platforms such as Carrd may face difficulties navigating the interface or require additional time to adapt to the non-conventional format of material delivery. These challenges highlight the importance of considering both pedagogical design and technological accessibility when implementing innovative educational approaches like STEAM.

Several limitations must be acknowledged in this study. First, the data analysis approach was primarily descriptive. The data were processed by presenting findings in the form of narratives and percentages without employing inferential statistical tests. Another limitation is that the study was conducted over a relatively short period, spanning only a few weeks. Consequently, it only measured the short-term impact of website use on student learning outcomes, while aspects such as knowledge retention and the sustainability of learning motivation could not be fully analyzed within this limited timeframe. Although Carrd was chosen for its ease of website development, it has constraints in supporting more complex interactive features, such as simulations, adaptive quizzes, or student data processing. Furthermore, not all students had equal access to digital devices and stable internet connections, which may have led to variations in their experiences with the learning website. These challenges highlight the need for further efforts to ensure that the website remains accessible to all students without technical barriers.

CONCLUSION

Based on the results of the analysis and discussion, it is concluded that the developed learning website meets the criteria of validity, practicality, and effectiveness. In terms of validity, the website was deemed highly valid by both subject matter experts and media experts, with validation percentages of 100% and 92.5%, respectively. This indicates that the content, language, and presentation, as well as the graphical and programming aspects, meet the required quality standards. Regarding practicality, the website received very positive responses from both teachers and students. The biology teachers rated the website with a practicality score of 96%, while students provided a score of 90.28%. These results suggest that the website is easy to use, well-structured, and engaging, making it a suitable learning tool. In terms of effectiveness, the learning website was proven to have a positive impact on student learning outcomes. The experimental class, which utilized the website, achieved an achievement level of 85%, indicating a significant improvement in learning achievement. These findings highlight the potential of the website as an effective digital learning resource that enhances students' understanding and engagement in the learning process.

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