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Development of a Project-Based Learning E-Module on Human Circulatory System Material

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ABSTRACT

The study aims to evaluate the validity, practicality, and cognitive learning outcomes associated with a project-based learning e-module designed for 11th-grade students at SMA Negeri 1 Kabila. Employing the ADDIE development model, data was collected using validation sheets and questionnaires. A trial was conducted with 15 students from class XI IPA 5 at SMA Negeri 1 Kabila. The results indicate that: 1) the validity score from media expert validation is 82.8% (Very Valid), and from material expert validation is 91% (Very Valid); 2) the practicality score based on student questionnaire responses is 86.3% (Very Practical), and from teacher questionnaire responses is 89% (Very Practical); 3) students' cognitive learning outcomes, as demonstrated by pretest and post test results, show a classical percentage score of 75%, with an N-Gain score of 0.75, categorized as (High). Based on these findings, it can be concluded that the project-based learning e-module on the human circulatory system is valid, practical, and effective for use in the Biology learning process at SMA Negeri 1 Kabila.

Keywords: E-module, Project-based learning, Human circulatory system, Cognitive learning outcomes

INTRODUCTION

The quality of education in Indonesia has seen improvement alongside the development of digital technology. Enhancements in educational quality are determined by teachers' creativity in developing teaching materials that cater to students' needs. Specifically, in the era of Society 5.0 with the introduction of the *merdeka belajar* curriculum, learning processes are more student-centered, granting teachers the freedom to interpret the curriculum to address each student's requirements in facing global competition for human resources. Intense competition in the field of education necessitates that teachers and students maximize the use of technology to make the learning process more efficient and engaging. The utilization of technology in education poses a challenge for teachers in creating teaching materials that will be used in the learning process. According to Hasan and Ahmad (2019), teachers are required to utilize and transform in the cyber pedagogy era or digital era. Moreover, teachers must also be creative and innovative in developing learning methods or finding solutions to learning problems, thus enhancing the quality of Information and Communication Technology (ICT)-based learning.

Teaching materials refer to a set of resources designed by teachers for instructional purposes to support students in achieving the expected basic competencies.

These teaching materials can include books and similar resources, as well as audio, video, and computer programs containing lesson content (Khulsum et al., 2018). Teaching materials serve as learning resources used to aid the learning process, such as modules. According to Majid (2020), modules are a systematic set of teaching materials presented to enable students to learn independently without direct guidance from a teacher as a facilitator. Ruganda (2021) defines teaching materials as a set of tools or learning aids containing lesson content, methods, limitations, and evaluation criteria, systematically designed and engaging to achieve the intended goals of attaining competencies or sub-competencies, with all their complexities. According to Olayinka (2016), teaching materials are various tools necessary for teaching and learning to: 1) Enhance teacher efficiency and improve student performance, making learning more practical, realistic, and engaging; 2) Enable teachers and students to actively and effectively participate in lesson sessions; 3) Provide students with opportunities to acquire skills, knowledge, develop self-confidence, and self-actualization.

As digital technology advances, traditional printed modules are shifting to digital or e-modules. E-modules are teaching materials packaged to be more practical and flexible, effectively improving students' learning outcomes. According to Hastari et al. (2019), e-modules effectively enhance student engagement and motivation, thus improving learning outcomes. According to Latifah et al. (2020), e-modules are instructional materials structured based on specific learning objectives and presented in electronic formats, incorporating animations, audio, and navigation, allowing users to interact more actively with the program. Various attractive features in e-modules create an engaging learning experience that prevents student boredom and facilitates independent learning.

According to Simamora et al. (2018), e-modules offer several advantages. Firstly, they are easily accessible online through various electronic devices such as smartphones, tablets, computers, or laptops. This accessibility allows students to engage with the learning material anytime and anywhere, enhancing flexibility in their study routines. Secondly, e-modules promote independent learning by providing structured content that students can navigate at their own pace. Thirdly, these modules feature interactive exercises that assess students' comprehension and mastery of the subject matter, offering immediate feedback to aid learning progress. Lastly, e-modules often incorporate authentic projects, encouraging collaborative efforts among students to complete tasks that simulate real-world scenarios. Despite these benefits, challenges associated with e-modules include technical issues, the need for digital literacy skills, and initial costs involved in developing and maintaining high-quality digital content.

The use of e-modules is determined by the accuracy of teachers in selecting appropriate learning models, such as Project Based Learning (PBL), which can enhance student learning outcomes and effectively solve problems, especially in biology education. According to Suryani and Saparuddin (2022), Project Based Learning is a teaching model that utilizes projects or activities as the main medium. Students engage in exploration, assessment, interpretation, synthesis, and information gathering to produce various forms of learning outcomes. This assertion is also supported by the research of Sugihartini and Jayanta (2017), who state that Project Based Learning is designed to address issues faced by students during learning by conducting in-depth investigations into specific topics, particularly in subjects like the human circulatory system.

The human circulatory system is a factual and conceptual topic within biology. This subject is often challenging for students due to its coverage of blood (components and functions), circulatory organs, circulation processes, and disorders of the circulatory

system. There are numerous concepts and sequential processes that students need to master, including difficulties in recalling scientific terms and comprehending processes within a complex system or the sequence of events. Most students tend to rely on rote memorization of content from printed textbooks, which can lead to a lack of motivation when faced with the extensive material that needs to be memorized. This situation is a significant factor contributing to the low learning outcomes observed among students of Class XI at SMA Negeri 1 Kabila, particularly in the topic of the human circulatory system, where the average score is 60, falling short of the school's minimum passing grade of 75.

Based on interviews with biology teachers at Class XI of SMA Negeri 1 Kabila, the use of teaching materials, especially in the topic of the human circulatory system, remains limited and lacks variation. The learning process still predominantly relies on the use of printed modules provided by the school. Teachers have not innovated or created effective printed modules to motivate learning tailored to each student's needs in understanding the subject matter.

Previously, SMA Negeri 1 Kabila used the 2013 curriculum, where both teachers and students were required to achieve learning objectives, even though students struggled to grasp the material effectively. The use of teaching materials such as modules and printed books has been long established, dating back to the implementation of the 2013 curriculum. The monotony in teaching materials under the 2013 curriculum necessitated innovation to improve student learning outcomes. With the introduction of the *merdeka belajar* curriculum, which emphasizes student-centered learning and adaptation to technology, both teachers and students at SMA Negeri 1 Kabila are required to adapt to technological advancements.

The implementation of the *merdeka belajar* curriculum is new at SMA Negeri 1 Kabila, particularly for Class XI, prompting teachers to adjust from using printed modules to digital modules. However, there is a need for further development of digital modules or e-modules, as teachers currently face limitations in creating and utilizing existing e-modules, primarily due to their limited understanding of technology. The presence of the *merdeka belajar* curriculum should ideally stimulate teachers to innovate and leverage evolving digital technologies, particularly in developing teaching materials.

In Class XI of SMA Negeri 1 Kabila, the development of e-modules has not been adequately implemented. In the era of Society 5.0, teachers should be capable of developing and innovating e-modules using digital technology to facilitate information delivery, particularly in the learning process. This situation can affect students' interest and motivation, thereby influencing their learning outcomes. The use of monotonous teaching materials can lead to student boredom, lack of enthusiasm, and reduced engagement in learning. This aligns with research conducted by Ceha et al. (2016), which suggests that continued use of monotonous teaching materials in the learning process can negatively impact the quality of education and student achievement.

Therefore, there is a pressing need for innovation in creating printed module teaching materials by adopting advances in digital technology. These innovations should aim to incorporate interesting, effective, creative, and varied content that is easy to use and flexible, meeting students' needs in the learning process. Such innovations can have a positive impact by preventing student boredom and providing a better learning experience both inside and outside the classroom. E-modules should be developed not only for classroom use but also for independent learning, allowing students to study anytime without the direct supervision of a teacher. Based on the issues outlined above, the researcher proposes to conduct a development study titled "Development of Project Based Learning-Based E-Module Teaching on the Human

Circulatory System in Class XI of SMA Negeri 1 Kabila."

METHODS

The research and development model used in this study is the ADDIE model. According to Rayanto & Sugianti (2020), the ADDIE development model consists of five stages: analysis, design, development, implementation, and evaluation. However, this study focuses on the limited-scale trial phase. In the analysis stage, the researcher conducted a needs analysis and analyzed the learning materials. For the design stage, the researcher designed an e-module using the Heyzine Flipbook application. During the development stage, the researcher developed the product as a whole and then validated it through expert validation by subject matter experts and media experts. The validation process involved a lecturer from the Department of Biology Education at Universitas Negeri Gorontalo. Following the validity testing, the product underwent a limited-scale trial in schools to assess the practicality of the project-based learning-based e-module on the human circulatory system. This included evaluating student learning outcomes based on pretests and posttests.

RESULT AND DISCUSSION

The e-module developed by the researcher offers several advantages, such as presenting materials in an engaging manner with clear explanations through the use of images and instructional videos. This approach facilitates independent and efficient learning review for students. The developed e-module addresses students' concerns about the need for instructional materials that are interesting, concise, and easy to understand. Moreover, it serves as a solution to the issue of low student learning outcomes in the human circulatory system topic. This is because the researcher's e-module can enhance student interest in learning about the human circulatory system, thereby positively impacting students' cognitive learning outcomes.

The development undertaken in this research involves creating a project-based learning e-module to enhance students' cognitive learning outcomes in the topic of the human circulatory system. This project-based learning e-module is a sequence of learning activities centered around projects. This approach aligns with research by Natalia (2021), indicating that e-modules can assist students in grasping material concepts based on real-world events embedded in project activities.

Project-Based Learning E-Module on the Human Circulatory System: Validation and Practicality Assessment

The development of the Human Circulatory System e-module began with designing the product, using a flowchart and storyboard as references for creating the e-module design with the Heyzine Flipbook application. The e-module was formatted in A4 paper size and designed comprehensively to include the cover page, module identity, foreword, table of contents, list of figures, user guide, introduction, concept map, syntax of project-based learning, learning activities, glossary, competency test, and bibliography. The project-based learning e-module on the human circulatory system has been validated by two expert validators: a lecturer in Biology Education from the Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Gorontalo. The media validation results indicate a high validity score of 91%. Details of the media validation results can be seen in Table 1.

Table 1. Media Validation Results for the E-Module

Aspects	∑Fx	N	Percentage	Criteria
Cover Design	10	10	100 %	Highly Valid
Text Message Design	28	30	93,3 %	Highly Valid
Image Message Design	20	20	100 %	Highly Valid
Video Message Design	12	15	80 %	Valid

Audio Message Design	12	15	80 %	Valid
E-Module Organization Design	9	10	90 %	Highly Valid
Average	91	100	91 %	Highly Valid

Media validation encompassed six aspects: cover design, text message design, image message design, video message design, audio message design, and e-module organization design. The cover design scored 100%, categorized as highly valid, showing that it is clear and appealing. Text message design, assessed based on text appropriateness, readability, punctuation, and color, scored 93.3%, indicating high validity.

Image message design scored 100%, showing clear image placement and alignment with textual content. Video and audio message designs received 80% each, indicating clarity and comprehension, rated as valid. E-module organization, focusing on usage clarity, scored 90% with high validity.

Material Validation

Material validation from experts achieved an average of 82.8%, indicating high validity. Detailed results are shown in Table 2.

Table 2. Material Validation Results for the E-Module

Aspects	**∑Fx**	**N**	**Percentage**	**Criteria**
Content Feasibility	9	15	60 %	Fairly Valid
Presentation Components	17	20	85 %	Highly Valid
Language	24	25	96 %	Highly Valid
Assessment Project Based Learning	8	10	80 %	Valid
Average	58	70	82.8 %	Highly Valid

Material validation covered four aspects: content feasibility, presentation components, language assessment, and project-based learning aspect. Content feasibility, scored at 60%, requires revisions to enhance comprehensiveness. Presentation components scored 85%, confirming appropriate alignment and organization.

The language aspect, rated at 96%, was evaluated based on clarity, grammar accuracy, and coherence, marking it highly valid. The project-based learning aspect scored 80%, deemed valid, showing the e-module aligns with project-based learning stages and aids critical thinking.

Practicality Assessment

To assess practicality, a questionnaire was given to a Biology teacher and 15 students from Class XI IPA 5 at SMA Negeri 1 Kabila. The results are shown in Tables 3 and 4.

Table 3. Teacher's Practicality Assessment Results for the E-Module

Aspect	**∑Fx**	**N**	**Percentage**	**Criteria**
Practicality	13	15	86,6 %	Very Practical
Readability	17	20	85 %	Very Practical
Usefulness	19	20	95 %	Very Practical
Average	49	55	89 %	Very Practical

Teacher responses show that the E-Module is very practical, with a total score of 89%. Practicality, readability, and usefulness were rated at 86.6%, 85%, and 95%, respectively, reflecting effective and efficient use, ease of comprehension, and the E-Module's utility in teaching.

Table 4. Student's Practicality Assessment Results for the E-Module

Aspect	**∑Fx**	**N**	**Persentage**	**Criteria**
Engagement	258	300	86 %	Very Practical

Material	258	300	86 %	Very Practical
Ease of Use	326	375	86,9 %	Very Practical
Average	842	975	86.3 %	Very Practical

Student responses reflect high practicality, with an average score of 86.3%. Engagement, material understanding, and ease of use were all rated as very practical, demonstrating that students find the E-Module easy and enjoyable to use.

Cognitive Learning Outcomes

Cognitive outcomes were assessed using pretest and posttest scores. The results indicate an improvement in learning outcomes, with 89% of students achieving mastery in the posttest. The classical N-Gain score of 0.75 was categorized as high. This data is summarized in Table 5.

Table 5. Cognitive Learning Outcomes

Standard Score	Number of Students	Classical Mastery Percentage	Classical N-Gain	Criteria
75	15 students	89%	0.75	High

The increase from pretest to post test scores shows that the E-Module effectively enhances understanding of the circulatory system. The high N-Gain indicates substantial improvement, supporting previous findings that interactive e-modules can significantly improve student achievement.

CONCLUSION

Based on the research conducted on the development of a project-based learning e-module for the topic of the human circulatory system in Grade XI at Senior High School, the following conclusion can be drawn: The validity of the project-based learning e-module has been confirmed for use in schools, as it received appropriate validation from two expert validators, with the material expert giving a score of 91% and the media expert providing a score of 82.8%, both classified as "Highly Valid. The practicality of the project-based learning e-module can be observed in two stages: the teacher response questionnaire and the student response questionnaire, which received scores of 89% and 86.3%, respectively, both classified as "Highly Practical." The cognitive learning outcomes of students using the project-based learning e-module showed a pre-test score of 25.60% and a post-test score of 81.93%, with an N-gain score of 0.75, categorized as "High."

Declaration by Authors

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