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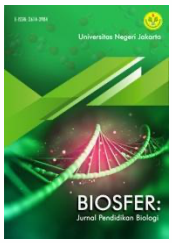

Development of a flipbook-based e-module on the human circulatory system

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ABSTRACT

Teaching materials for the human circulatory system are still limited to printed books, which lack interactivity and do not provide visual representations for understanding its anatomical structure. The development of interactive e-modules is needed to facilitate more effective learning through the integration of text, images, videos, and interactive elements. This research seeks to determine both the viability and student response to an interactive heyzine-based electronic module covering the human circulatory system submaterial, exploring its potential as a more engaging alternative educational resource. The study employed a modified Research and Development methodology based on the Borg and Gall model as adapted by Sugiyono. Researcher selected participants through purposive sampling, involving 36 eighth-grade junior high school students. The research utilized validation sheets and student response questionnaires. The research instruments were validated by 5 expert validators. The researcher used content validity analysis methods, specifically Aiken's V coefficient, to analyze the collected data. Reliability testing using Intraclass Correlation Coefficients. Assessment of student response questionnaire using the Likert scale. The teaching material validation analysis produced an average score of 0.92, placing it in the valid category. Reliability testing yielded a score of 0.806, which falls within the good classification. Students responded favorably to the developed educational materials, with an average positive response rate of 77.57%, indicating good reception. Based on these findings, we determined that the developed heyzine-based electronic module covering the human circulatory system sub-material is appropriate for educational implementation.

INTRODUCTION

Multiple factors contribute to learning process effectiveness, including educator roles (Damayanti et al., 2024), teaching material (Prabowo et al., 2022; Putra et al., 2023; Setyo et al., 2022), learning media (Permana et al., 2024; Saputra & Gunawan, 2021), learning methods (Leuwol et al., 2023), material delivery (Djalo et al., 2023), school facilities (Dila et al., 2024), and environmental conditions from teachers and classmates (Ananda, 2019). Teaching material plays a crucial role in enhancing learning effectiveness. Sungkono (2009) noted that using teaching materials can improve the learning process and make it more effective because teachers have more time to guide students. Furthermore, teaching materials help students master competencies coherently and systematically (Eliyanti, 2016; Ritonga et al., 2022) while fostering more excellent self-directed learning capabilities (Aliyah, 2022; Magdalena et al., 2020; Salamah et al., 2023; Sungkono, 2009). One form of teaching material that can support students' learning independence is modules (Aliyah, 2022; Setiyadi et al., 2017; Sirate & Ramadhana, 2017). A module is an independent learning package that includes a series of learning experiences that are systematically planned and designed to help learners achieve learning objectives (Muntoro & Puspasari, 2017; Setiyadi et al., 2017; Zakir, 2013).

Modules are categorized into physical printed modules and digital electronic modules (e-modules). Along with the rapid development of technology, electronic modules are currently more in demand by students. Electronic modules allow students to access learning materials anywhere and anytime through various digital devices such as computers, laptops, and smartphones (Mutmainnah et al., 2021; Sa'diah et al., 2022). Electronic modules integrate diverse multimedia elements, including text, images, video, audio, and animation, enabling students to actively engage with content and develop a deeper understanding of the material presented by instructors (Ramadhan et al., 2023). According to Sa'diah et al. (2022) that electronic modules feature navigational elements in the form of links, allowing students to control and direct their learning experience independently. Learners can switch pages and watch and pause available videos or animations. By utilizing e-modules, educators prompt students to engage in various activities, including video observations, experimental work, and quiz completion, providing learners with opportunities for independent study (Manzil et al., 2022). Electronic modules can be developed using various digital platforms, one of which is the Heyzine application, which allows the incorporation of interactive elements that can increase engagement, understanding of the material, and learner independence.

Heyzine is a web-based application that produces flipbooks in HTML format that can be accessed through various devices such as Android, iPhone, tablet, or personal computer (Erawati et al., 2022). The Flipbook application's advantages are the forms of digital or electronic book publications (Syah, et al., 2025). According to Sari & Pratiwi (2024), it creates more interesting e-modules by adding videos, images, graphics, sounds, and links. Heyzine can also provide an experience similar to opening a physical book due to the animation effect when switching pages (Muljo et al., 2024). Another advantage is that heyzine can be accessed easily anywhere and anytime, stimulating learners to learn according to their abilities and speed of understanding (Doyan et al., 2024; Sari & Pratiwi, 2024). It also provides flexibility where teachers only need to share the link, and learners can download it for free (Manzil et al., 2022). Heyzine can also improve learners' understanding of abstract concepts or events that are difficult to understand in the classroom. This result is consistent with research Doyan et al. (2024) that demonstrated that thermodynamics textbooks enhanced with heyzine application effectively improve students' conceptual understanding. The beneficial features of heyzine enable the implementation of a learning process that emphasizes student-independent learning.

Biology is a branch of science that studies all aspects of life (Zahra et al., 2021). However, students often experience difficulties learning biology because the concepts are abstract and involve a series of complex mechanisms in living things (Dewantara et al., 2020). The independent curriculum solves this problem by developing interactive and fun biology learning, especially using technology. The curriculum additionally upholds the concept of self-directed learning, enabling students to study according to their individual learning preferences while simultaneously facilitating teachers' efforts to develop instructional processes (Rahmayumita & Hidayati, 2023). Unfortunately, implementing an independent curriculum is not free from obstacles, such as limited technological infrastructure, uneven internet access, and the need to develop digital skills for teachers (Liriwati et al., 2024). One important topic in biology that is often considered difficult is the human circulatory system. (Astuti et al., 2023; Aziza et al., 2021). Based on curriculum analysis, the scope of the human circulatory system material consists of the structure and function of the organs of the circulatory system, diseases related to the human

circulatory system, and how to maintain the human circulatory system. Furthermore, Dharmawan et al. (2023) & Nurharyani et al. (2015) mentioned that the human circulatory system mechanism is considered difficult to understand because it occurs inside the human body, making it impossible for students to observe it directly. Therefore, based on these characteristics, the circulatory system material is suitable for a heyzine-based electronic module.

So far, previous research on using heyzine-based e-modules as biology teaching materials includes Amelya (2024) developing interactive electronic modules using flipbook formats to facilitate learning of the human respiratory system material. The heyzine-based e-module developed by Amelya (2024) can visualize material through multimedia integration, such as videos related to the human respiratory system, interactive images of respiratory organs, and word wall-based quizzes for self-evaluation. Moreover, the e-module garnered favorable feedback from students during small-scale testing sessions. So, it can be concluded that the e-modules developed are effective in enhancing students' understanding of abstract biological concepts and supporting independent learning. Furthermore, Mahrawi et al. (2023) stated that the e-module based on hydroponic cultivation heyzine effectively visualizes plant growth and development material and gets a positive response from students. However, these studies have several limitations, namely that they have not integrated the guided inquiry learning model. To overcome these limitations, this study presents innovations, including integrating the learning stages of flipbook-based e-module learning with guided inquiry syntax. Additionally, this study integrates interactive videos, practical guides, and interactive quizzes.

Based on this description, this study is conducted to assess the feasibility of flipbook-based e-modules on the human circulatory system sub-material and to determine student responses to the e-modules. As an effort to address the limitations of previous research, the researcher hopes that developing this e-module will provide an innovative solution to enhance the quality of biology learning, especially in the human circulatory system material.

METHODS

Research Design

This research adopts the Research and Development (R&D) approach. The development procedure refers to the Borg and Gall model (Borg & Gall, 1983), which has been modified by Sugiyono (2021). This model consists of several stages, including identifying potential problems, collecting data, designing the product, validating the design, revising the design, conducting product trials, revising the product, implementing usage trials, revising the product further, and proceeding to mass production. The researcher selected this modified development model because it offers a systematic framework and is easy to apply in developing learning products. In this study, the researcher limited the development process to seven stages.

Population and Samples

This study's population consisted of eighth-grade students from three public junior high schools in West Kalimantan Province. The researcher selected schools based on criteria, namely public schools located in Pontianak City and Kubu Raya Regency, Indonesia, with an accreditation and that implement the independent curriculum. This study employed purposive sampling, which selected samples based on specific characteristics relevant to the research's purpose. The selection of students was based on recommendations from science subject teachers, considering students' learning abilities categorized into high, medium, and low levels. The detailed sample distribution is presented in Table 1.

Table 1
Research sample

	Male	Female	Total	Percentage
School A	6	6	12	33.30%
School B	6	6	12	33.30%
School C	6	6	12	33.30%
Total	18	18	36	100.00%

Instrument

The instruments used in this study included e-module validation sheets and student response questionnaires. Five expert validators conducted the validation process. The aspects evaluated in the e-module validation were content, presentation, and language feasibility. Content eligibility includes

suitability of material with learning outcomes, material accuracy, and encourages curiosity. Feasibility of presentation includes display quality, software engineering, consistency, and graphics design. Language feasibility includes straightforward, communicative, appropriateness to learner development, graphical elements, and the use of terms, symbols, or icons (BSNP, 2008). The learner response questionnaire assesses affective, cognitive, and conative aspects. Affective aspect includes motivation and attractiveness. Cognitive aspect includes clarity of instructions for using the module, appearance suitability, and understanding of material content. Conative aspects include behavior (Amir, 2015).

Procedure

The potential and problem analysis stage includes analyzing needs, characteristics of students, and curriculum. The researcher conducts needs analysis by interviewing teachers about the issues they face, especially regarding the use of teaching materials on the human circulatory system sub-material. At this stage, it was revealed that teaching materials on the human circulatory system were still limited to printed materials and were less interactive. In addition, teachers have difficulty providing material and practice to students during the learning process due to the limited time allocation.

Analyzing learners' characteristics aims to obtain an overview of individual or social skills that can be developed to achieve learning objectives. This analysis shows that the age range of grade VIII students is 13-14 years old, which, according to Piaget's theory, is in the formal operational stage. At this stage, learners begin to be able to think abstractly and hypothetically. On the other hand, the analysis also revealed that learners depend on the internet.

Furthermore, the curriculum analysis stage is carried out by considering the characteristics of the curriculum implemented in schools. This stage aims to identify the learning objectives and the scope of the material that will serve as a reference in developing teaching materials. The curriculum applied in the school is the Independent Curriculum. The learning objective flow for the circulatory system sub-material includes students being able to recognize the structure and function of the circulatory organs, understand diseases associated with the circulatory system, know how to maintain a healthy circulatory system, analyze data in the form of blood flow graphs, gather information about circulatory system diseases, and apply the knowledge gained to create a guide for a healthy lifestyle aimed at preventing and alleviating diseases related to the human circulatory system.

After analyzing potential and problems, the data collection stage continued. The data collection stage includes the literature study and field study stages. The literature study focused on analyzing the learning objective flow of the Independent Curriculum based on the learning outcomes and objectives of the human circulatory system sub-material. In addition, the field study aimed to gather data directly from real situations related to the research topic.

Furthermore, the design stage of teaching materials includes preparing human circulatory system material, images, videos, hyperlinks, and attractive and appropriate backgrounds. The e-module development process consists of two main stages: designing the content with the help of Canva Pro and converting it into a flipbook format using the Heyzine platform. The initial stage of e-module development begins with making a storyboard as a basic framework for designing teaching materials. After that, the preparation of learning components refers to the guided inquiry model, which aims to create an interactive and in-depth learning experience for students. At this stage, developers also design the layout, apply visual elements (images, videos, and infographics), and select appropriate color and font combinations. The final stage involves converting the module into a flipbook using the Heyzine application. At this stage, the researcher added interactive features that make it easier for learners to explore the e-module and increase learner engagement.

The next process includes validating the e-module design by validators and reliability testing of the assessment instruments. After receiving feedback from validators, the researcher revised the e-module and conducted a limited trial with students. Based on the trial findings, further revisions were made to improve the quality of the e-module.

Data Analysis Techniques

The data obtained from expert validation were analyzed to determine the feasibility of the e-module in terms of content, presentation, and language aspects. The assessment process utilized a Likert scale, which is commonly used to measure individual or group attitudes, opinions, and perceptions toward specific research variables (Sugiyono, 2021). Validators assessed the e-module validation sheet

by providing a checklist on one of four rating categories: 4 (very good), 3 (good), 2 (less good), and 1 (not good). In addition, the validity of the e-module was analyzed using Aiken's V formula (Aiken, 1985). The instrument was declared valid if the Aiken's V value was equal to or greater than 0.87. This criterion was determined by involving five validators who gave an assessment using four rating categories and at a significance level of 5% (α 0.05).

After the validity of the e-module is declared valid, it is necessary to conduct a reliability analysis to measure the consistency of the assessment between validators. The analysis was conducted using the Intraclass Correlation Coefficients (ICC) method using IBM SPSS Statistics 25 software. The model used was two-way mixed effects, multiple raters' type, and absolute agreement definition. ICC was chosen because this method is suitable for measuring inter-rater reliability in subjective assessments. The instrument is declared reliable if the ICC value is equal to or more than 0.75 and the p-value is less than 0.05. ICC assessment criteria refer to Arum et al. (2022). ICC values less than 0.50 are considered to have low reliability, values between 0.50 and 0.75 indicate medium reliability, values from 0.75 to 0.90 demonstrate good reliability, and values ranging from 0.90 to 1.00 represent excellent reliability.

After the instrument met the validity and reliability requirements, the researcher collected data on students' responses using a student response questionnaire. The type of questionnaire applied in this study was a closed-ended questionnaire. This type of questionnaire presents predetermined answer choices, where respondents are required to select the option that best represents their opinion by marking a checklist. The student response assessment employed a Likert scale consisting of four response categories: SS (strongly agree), S (agree), TS (disagree), and STS (strongly disagree). The collected data was then analyzed by calculating the percentage of student responses. Furthermore, students' responses to the developed teaching materials were classified by comparing the percentage results with positive criteria (Riduwan, 2022).

RESULTS AND DISCUSSION

The development of teaching materials is one of the components that supports the effectiveness of the learning process. This study produced an electronic module based on flipbook with the help of the heyzine platform with the integration of the guided inquiry learning model and specifically aims to make it easier for students to understand the concept of the human circulatory system. The developed electronic module has several advantages, including educational videos, interactive questions, guided inquiry activities, and the e-module can be accessed anytime via smartphone or laptop (https://heyzine.com/flip-book/5b3990ece7.html). The initial section of the e-module includes a cover page, introduction, table of contents, module usage guidelines, learning outcomes, learning objective flowchart, and concept map. The main content consists of two sub-chapters: the structure and function of organs and diseases related to the human circulatory system. Each subchapter is equipped with learning activities that include observing infographics or videos, formulating questions, experimenting with simulations or experiment activity guides, reading material enriched with multimedia, and summarizing concepts that help students understand the circulatory system gradually. The final section includes a summary, comprehension test, evaluation (scoring guidelines), glossary, bibliography, and back cover page.

The heyzine platform provides a digital reading experience similar to turning the pages of a physical book, and can be accessed via the link https://heyzine.com/flip-book/5b3990ece7.html. The key advantage of this e-module lies in the heyzine platform, which enables the e-module to be accessed on smartphones, tablets, laptops, or desktop computers, as well as its offline reading feature, allowing students to access materials without an internet connection—a feature that supports learning in areas with limited internet connectivity. Additionally, the e-module includes several interactive features, such as educational videos that can be played directly without opening another app, interactive quizzes that provide immediate feedback to students, experimental activities through the LiveWorksheet platform, and discussion activities using the Padlet platform, which facilitates peer-to-peer discussions among students.

The results of the e-module development research were evaluated through two aspects: the feasibility of the e-module based on validator assessments and student responses after using the e-module. The following presents the analysis results of both aspects.

1. Validation of Heyzine-Based E-module on Human Blood Circulatory System Sub-matter

The validation process aims to provide suggestions for improvement before this electronic module is implemented for students. Competent experts must validate the electronic module to ensure it meets

eligibility standards. This validation includes three assessment aspects: content feasibility, presentation, and language. The outcomes of the validation process for the heyzine-based e-module on the human circulatory system are presented in Table 2.

Table 2
Validation results of the heyzine-based e-module on the human circulatory system.

	Indicator	Average	Description
Content	Suitability of material with learning outcomes	0.93	Valid
	Material accuracy	0.88	Valid
	Encourages curiosity	0.87	Valid
	Total	0.89	Valid
Presentation	Display quality	0.90	Valid
	Software engineering	0.93	Valid
	Consistency	0.93	Valid
	Graphics design	0.91	Valid
	Total	0.92	Valid
Language	Straightforward	1.00	Valid
	Communicative	1.00	Valid
	Appropriateness to learner development	0.93	Valid
	Graphical elements	0.96	Valid
	The use of terms, symbols or icon	0.96	Valid
	Total	0.97	Valid

a. Content eligibility aspect

The content feasibility aspect comprises three indicators. The first indicator, which assesses the alignment of the material with learning outcomes in the flow of learning objectives, achieved an average score of 0.93, falling into the valid category. According to the validator's evaluation, the e-module is deemed suitable for content because the material is comprehensive, adheres to the curriculum, includes contextual discussions, and introduces concepts and case examples that match students' competency levels (Figure 1). This is consistent with the perspective of Senja et al. (2024), who emphasize that e-module content must align with core and essential competencies, cater to student characteristics, and ensure the accuracy and relevance of the material. Consequently, the material presented in the e-module aligns with pertinent concepts and real-world examples.

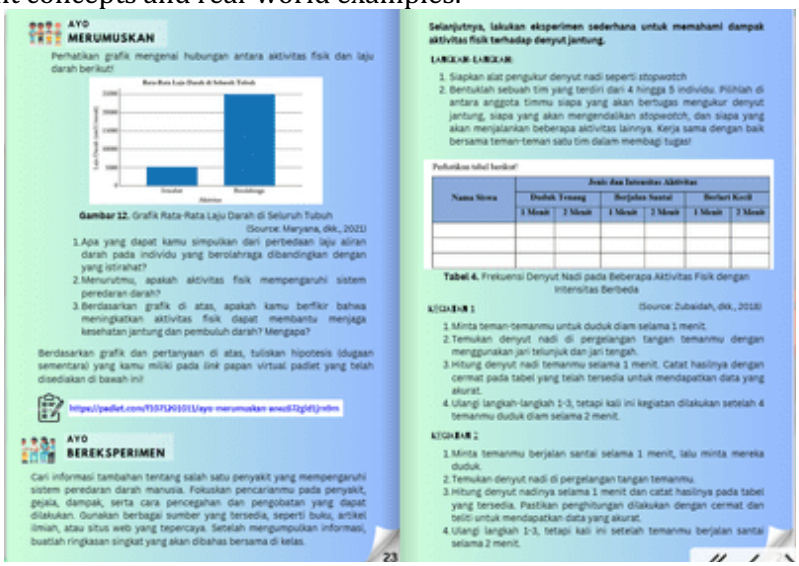
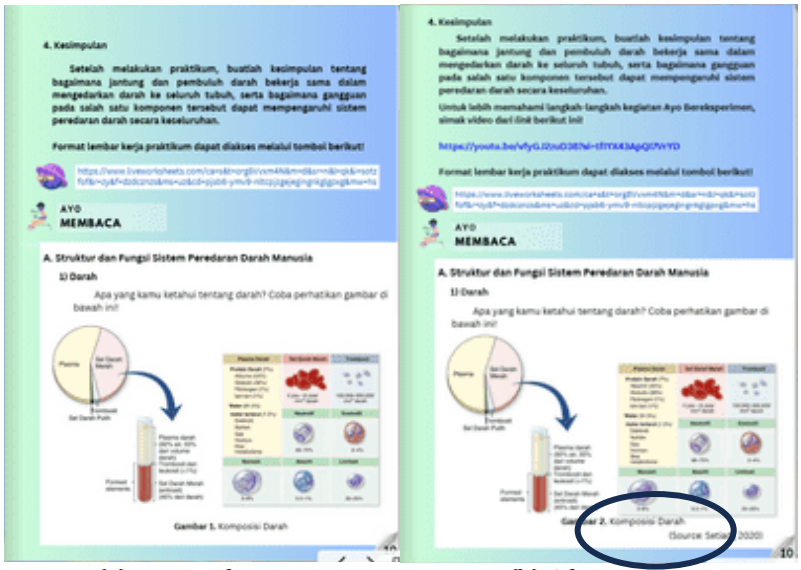


Figure 1. Example of Content Presentation of Heyzine-Based E-Modules that Present Contextual Discussion.

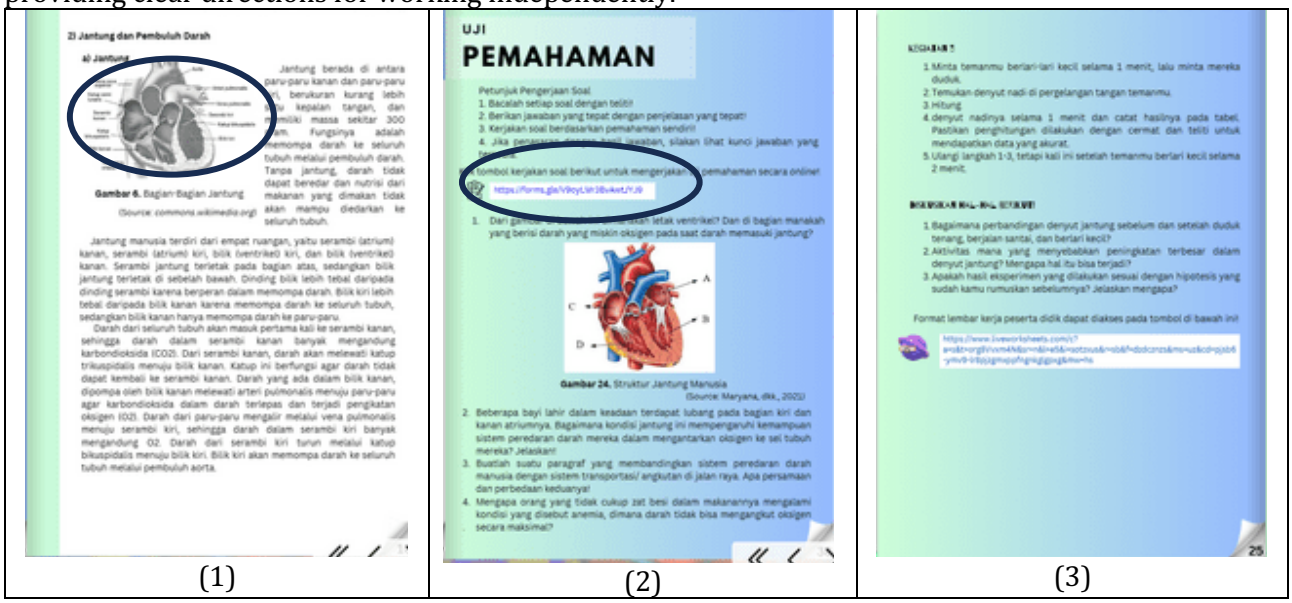
Additionally, the second indicator, which evaluates the accuracy of the material, obtained an average score of 0.88 and was categorized as valid. According to the validator's feedback, reference sources should be incorporated into tables, images, and learning videos (Figure 2). This aligns with the viewpoint of Winatha et al. (2018), who emphasize the importance of including sources in images and illustrations to avoid copyright violations.



(a) Before revision (b) After revision

Figure 2. Addition of Heyzine-based E-Module Reference Sources.

The third indicator, which focuses on encouraging curiosity, achieved an average validation score of 0.87, falling into the valid category. This assessment is based on the validator's observation that the developed e-module effectively enhances students' interest in learning, promotes independent learning, and builds their skills in completing practical tasks. According to Manzil et al. (2022) the existence of learning videos, experimental activities, quizzes, and games can be an attraction for students when learning. In addition, according to the validators, the e-module of this study also allows students to learn at their own pace without being bound by time and place. This statement aligns with the view of Manzil et al. (2022), who argue that e-modules can motivate students to engage in the learning process independently, as they include tasks or questions that students can complete independently. Furthermore, according to Pratiwi (2024) e-modules also play an essential role in providing clear directions for working independently.



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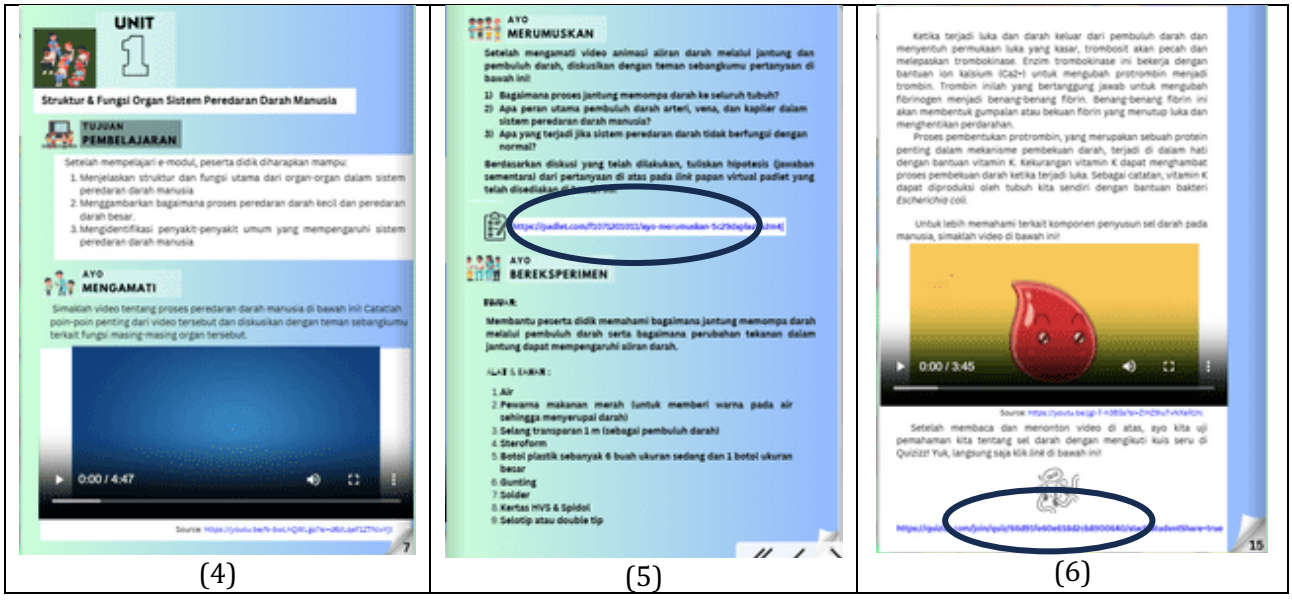


Figure 3. Presentation of Interactive Features on Heyzine-Based E-Modules (1. Images, 2. Comprehension Test Questions, 3. Let's Experiment Activities Through Liveworksheet Links, 4. Learning video media, 5. Let's Formulate Activities Through Padlet Links, 6. Quiz).

b. Presentation feasibility aspect

The presentation feasibility component contains four indicators. The first indicator, which assesses display quality, achieved an average score of 0.90, which is classified as valid. This indicates that the module's visual aspects have met the feasibility standards. The user-friendly design reflects this through the selection of font type and size, font color, icons or buttons, and the clarity of menus and materials, all designed with user needs in mind. The selection of font type and size aims to help distinguish the type of content of the title, subtitle, and paragraph. This idea aligns with the opinion of Prayoga et al. (2024), who state that the correct font variation can help differentiate between titles, subtitles, and main text, making it easier for readers to navigate pages. In addition, the text color must also contrast with the background to enhance readability. (Figure 4). This is reinforced by the perspective of Febriana et al. (2024), who state that the right color combination affects students' comfort and interest in reading. Electronic modules are made attractive by combining colors with children's psychology. Consistent with the viewpoint of Astuti et al. (2023) the use of color affects the psychology of the user, where the right color selection can stimulate and give birth to an impression to the reader.

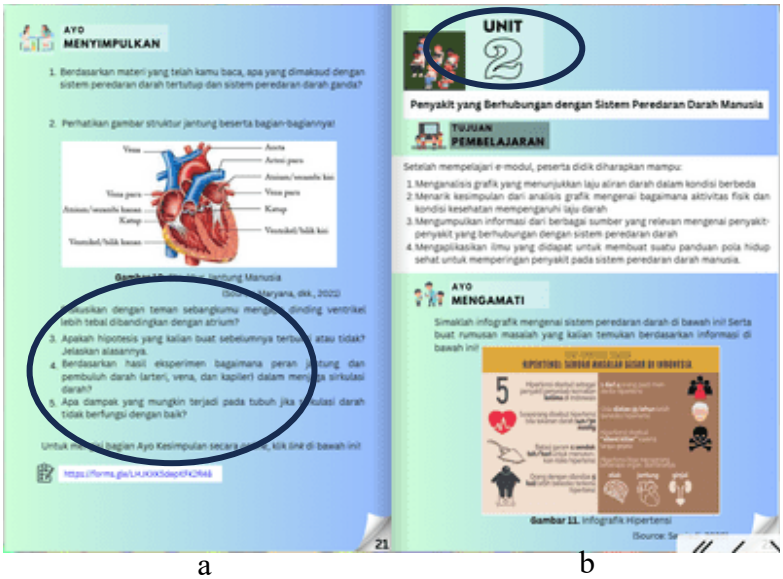


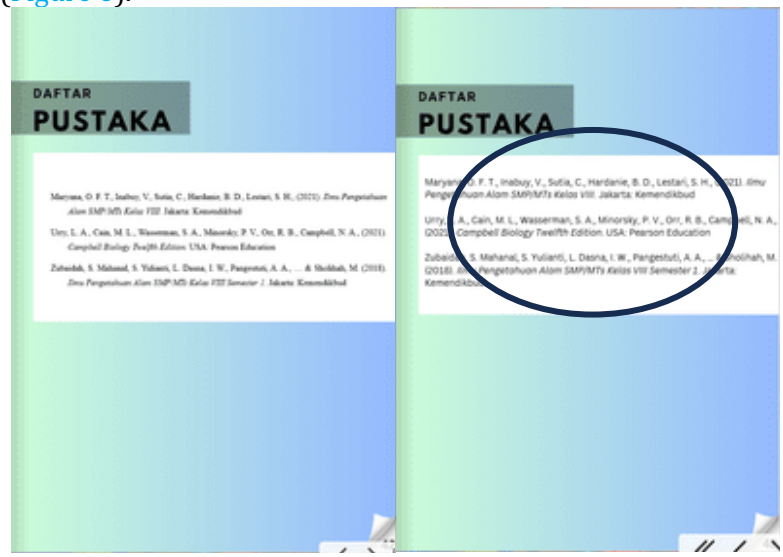
Figure 4. Presentation of Writing and Background Colors (a. The font is black. b. The background uses a gradation of light green and light blue)

The following criterion is the use of icons or buttons. The validator provided suggestions, such as adding a menu button that leads directly to the table of contents section, which aims to save students time finding the desired material content (Figure 5). This suggestion aligns with the opinion of Faishal et al. (2024) that adding direct navigation options to specific pages in the module can increase ease of access for learners.

(a) Before revision (b) After revision

Figure 5. Adding Menu Button to Heyzine-Based E-Module

The following criterion is the clarity of the menu and material. The menu in the Heyzine-based e-module features straightforward and memorable icons, making it user-friendly for students. Some available menus include the music on/off menu using a speaker icon, the previous page menu with an arrow icon pointing to the left (<), and the following page menu with an arrow icon pointing to the right (>). According to Winatha et al. (2018) using icons with images that are easy for students to remember makes accessing all the material easier. Moreover, the validator offered suggestions regarding the module's appearance, explicitly recommending changing the screenshot format to directly typed content. This revision aims to improve the material's clarity to provide learners with a more comfortable reading experience (Figure 6).

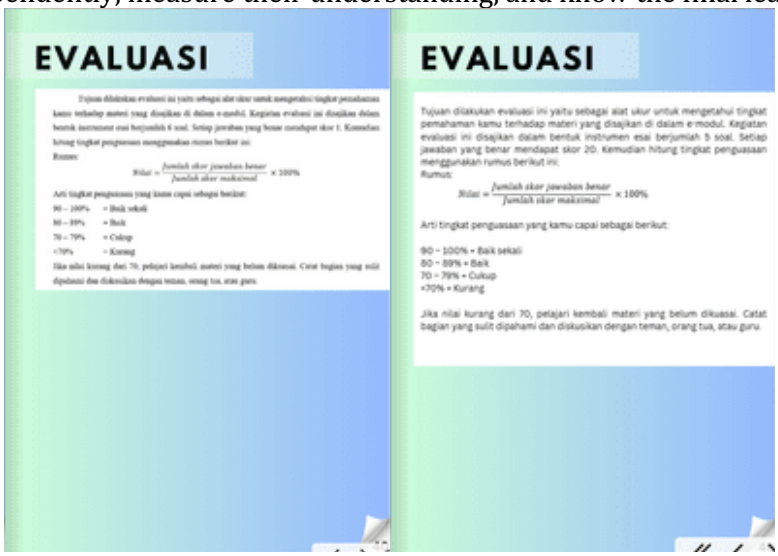


(a) Before revision (b) After revision

Figure 6. Screenshot format converted to Live Typed Content

The software engineering indicator achieved an average score of 0.93, which is categorized as valid. This score reflects the module's well-designed interface, systematic material organization, and clear general instructions, which all contribute to its overall quality. The e-module interface provides easy navigation, allowing learners to quickly understand the module without additional training and

access it through various devices. Consistent with the perspective of Doyan et al. (2024) learners can access Heyzine-based e-modules through multiple devices such as computers, smartphones, tablets, or personal computers. Furthermore, the e-module systematically organizes the material so that students can easily follow the learning flow. In line with Aliyah (2022) the module is one of the teaching programs systematically arranged, operational, and directed for use by students. Additionally, regarding the clarity of general instructions in the e-module, the validator recommended including a maximum score for the comprehension test questions to assist students in understanding the assessment weightings (Figure 7). This aligns with Lastri (2023) opinion, e-modules must have explicit instructions to help students learn independently, measure their understanding, and know the final learning objectives.



(a) Before revision (b) After revision

Figure 7. Addition of Maximum Score on Comprehension Test Questions

The next indicator on consistency obtained an average score of 0.93 with a valid category. This assessment is based on consistently using words, terms, and sentence structure in the e-module to prevent confusion. According to Taufik et al. (2024) consistent terminology and straightforward, focused sentence structures help users easily grasp the intended message. According to Aziza et al. (2021), proper sentence structure and word choice help readers understand the intended meaning better. In addition, the e-module consistently sets the spacing between text and illustrations to make it easy for students to read. Winatha et al. (2018) stated that the space between texts is adjusted to provide comfort for students in reading the contents of the e-module. E-modules do not use too many font combinations. Although there are several variations of fonts in the e-module, their use remains consistent throughout the e-module. This consistency creates a structured appearance so that the e-module can attract learners' attention. This concept aligns with the opinion of Prayoga et al. (2024) stating that combining font variations with the proper layout in e-module design can create an attractive visual structure and facilitate understanding of the content.

The graphic indicator achieved an average score of 0.91, falling into the valid category. This score reflects the balanced layout of text, images, and interactive elements in the e-module, making it user-friendly and easy to comprehend. As noted by Prayoga et al. (2024) a visually appealing design with a well-organized layout enhances the clarity of the material. Similarly, Meldrawati et al. (2023) emphasize that students are more drawn to e-modules when the layout is engaging and includes video or animation elements, which can boost their motivation, interest, and creativity. Furthermore, the e-module arranges illustrations and images proportionally, enhancing the explanation of the concepts it presents. According to Manzil et al. (2022), appropriately proportioned images help students understand the material more effectively. Consistent with Prayoga et al. (2024) perspective, the thoughtful placement of illustrations can significantly enhance comprehension and learning outcomes.

The e-module display design criteria also depend on the ability level and age of the learners who are the target users. Herlina (2019) found that e-modules align with students' needs and level of thinking maturity, facilitating independent learning and reducing difficulties in understanding the material. Furthermore, on the criteria for selecting the font type, color, and size, the type of font used in

the e-module varies (Figure 8). The fonts used include Montserrat, size 31 for the e-module title; League of Spartan, size 22.90 for the words "Modul Ajar IPA Kelas VIII" " Roboto, size 19.6 for small sub-titles; League of Spartan, size 35.41 for large sub-titles, and Canva Sans size 14 for the content of the material.

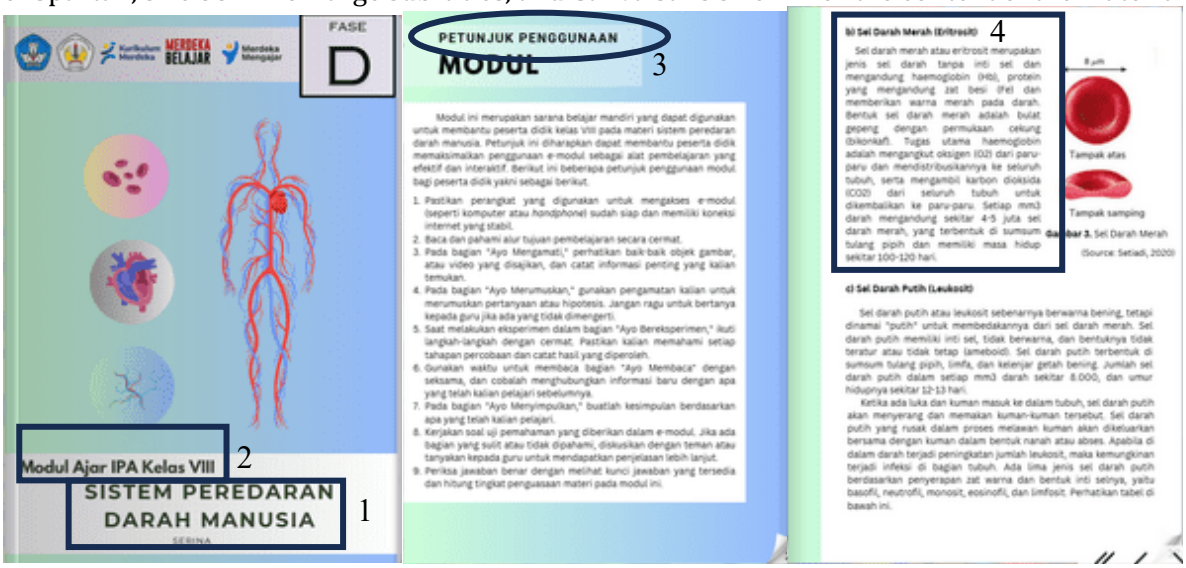


Figure 8. Presentation of Fonts Used in Heyzine-Based E-Modules (1. Montserrat, 2. League of Spartan, 3. Roboto, 4. Canva Sans)

c. Language feasibility aspect

The language feasibility aspect includes five indicators. The straightforward indicator received an average score of 1.00 with a valid category. The sentences in the e-module are considered good in terms of the accuracy of the structure to convey the message, the effectiveness of its use, and the standardization of terms according to function. The criteria for the accuracy of the sentence structure show that the sentences in the e-module are structured correctly so that they do not cause ambiguity. Aziza et al. (2021) stated that the correct sentence structure and word choice can make it easier for readers to understand its meaning. In addition, the information presented in the heyzine-based e-module is brief, concise, clear, and straightforward. As stated by Ramadhan et al. (2023) e-modules should be designed using clear and simple language to ensure students can easily access the material, fostering effective and efficient learning. Furthermore, the criteria for standardizing the terms used are by function, meaning that the terms used in this research e-module are by the General Guidelines for Indonesian Spelling (PUEBI). These results are consistent with the view of Taufik et al. (2024) who emphasize that e-modules should adhere to correct Indonesian language rules to enhance students' understanding of concepts and the learning process.

The communicative indicator achieved an average score of 1.00, which is classified as valid. This score reflects the module's effectiveness in clearly delivering messages or information. As Herlina (2019) highlighted, e-modules serve as teaching materials that support independent learning and must use language that is easy to understand and engaging. The next indicator, which evaluates the suitability for students' development, achieved an average score of 0.93 and was categorized as valid. This assessment is based on the language used in the e-module, ensuring it matches students' cognitive abilities and emotional maturity levels. E-modules use words, sentences, and concepts to assess the thinking ability of students at the junior high school level. According to Muljo et al. (2024) the language in e-modules should be tailored to match students' capabilities. In addition, according to the validator, the language used in the e-module can stimulate students' interest and enjoyment while reading. According to Amimah et al. (2023) the language used in developing teaching materials should be able to arouse a sense of pleasure or encourage enthusiasm for reading and studying teaching materials thoroughly.

The next category of indicators regarding graphics gets an average score of 0.96, classified as valid. This value is obtained because the use of grammar and spelling in the e-module is appropriate. Prayoga et al. (2024) stated that using sound and correct grammatical arrangements shows the existence of writing skills by the Big Indonesian Dictionary (KBBI). Consistent with the view of Amimah et al. (2023), the grammar used should adhere to the standards of the Big Indonesian Dictionary (KBBI),

and the spelling must follow the General Guidelines for Indonesian Spelling (PUEBI). Finally, the indicator of using terms, symbols, and icons achieved an average score of 0.96 which is classified as valid. The assessment considers whether the terms used in the text are consistent with the definitions listed in the glossary. The glossary serves to help readers understand the terms in the e-module. According to Mahrawi et al. (2023) the glossary allows learners to obtain information in the e-module. In addition, clear fonts and appropriate sizes are also essential to ensure learners can read comfortably. Consistent with the perspective of Meldrawati et al. (2023), appropriate font types and sizes can significantly influence learners' ease and comfort when using e-modules.

The validity analysis of the three aspects indicates that the teaching materials developed in this research are appropriate for implementation. However, high validity is not enough if the measuring instrument used is not reliable. Therefore, a reliability test is necessary to ensure the measurement results remain consistent. The analysis reveals an average ICC value of 0.806, which falls into the good category (Arum et al., 2022).

2. Learners' Response to Heyzine-Based E-module on Human Blood Circulatory System Sub-matter

Following the validation process, the researcher conducted a limited trial of the Heyzine-based e-module with 36 students. The average outcomes of the analysis of student responses are presented in Table 3.

Table 3
Learner Response Analysis Results

	Indicator	Score (%)	Categories score
Affective	Motivation	78.47	Strong
	Attractiveness	81.25	Very strong
Cognitive	Clarity of instructions for using the module	75.86	Strong
	Appearance suitability	78.47	Strong
	Understanding the material's content	75.83	Strong
Conative	Behavior	77.08	Strong
Average		**77.57**	**Strong**

a. Affective aspect

The affective aspect includes two indicators. The first indicator, motivation, reaches a value of 78.47% in the 'Strong' category. This value indicates that e-modules enhance students' enthusiasm for learning due to easy-to-use navigation between pages, responsive buttons, and teaching videos that play directly. The navigation feature between pages on the e-module allows students to easily move from one page to another. Additionally, the second indicator, which assesses attractiveness, achieved an average of 81.25%, categorized as "Very Strong." This suggests that the design and presentation of the material in the e-module effectively capture students' interest.

b. Cognitive aspect

The cognitive aspect includes three indicators. The first indicator, clarity of instructions for using the module, achieved an average of 75.86% in the 'Strong' category. This score indicates the use of straightforward and accessible language. This aligns with the perspective of Astuti et al. (2023) who emphasize that e-modules should be user-friendly, featuring clear usage instructions and simplicity for users to comprehend. Furthermore, the second indicator, namely the suitability of the display, achieved an average of 78.47% in the "Strong" category. This value is achieved because the layout, typography, and color composition are easily read. In addition, this criterion also includes the suitability of images with material and ease of access on laptops and cellphones. Additionally, the third indicator, which assesses understanding of the material's content, reached an average score of 75.83%, falling under the "Strong" category. The material's depth is appropriately matched to the students' cognitive level, contributing to this result.

c. Conative aspect

The conative aspect includes one indicator, behavior, which achieved an average score of 77.08, categorized as "Strong." This score reflects the module's engaging and interactive design, which motivates students to participate more actively in the learning process.

CONCLUSION

The Heyzine-based e-module focusing on the human circulatory system sub-material has been

validated as appropriate for educational use. Based on the validation results, the five validators gave an overall rating of 0.92, placing it in the valid category. In addition, the reliability test results reinforce this finding, achieving a score of 0.806, which falls into the good range. Additionally, learner response assessment results indicate a favorable reception of this electronic module among students, evidenced by the mean score of 77.57%, which qualifies as a strong category. The results indicate that students can effectively use the Heyzine-based e-module on the human circulatory system sub-material as a valuable teaching tool. This study suggests that science teachers can develop similar teaching materials with a broader scope. In addition, schools need to pay attention to the availability of a stable internet connection so that students can access e-modules without problems and ensure the availability of learning devices such as computers, laptops, or tablets that can be used by students in accessing e-modules considering that not all students have personal devices.

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