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Guided Inquiry-Based Electronic Module Development on Circulation System Ma-Terial to Improve Student Learning Outcomes

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Abstract

Background: Industrial era 4.0 has impacted the world of education. This affects students, where students can understand subject matter such as biology, which contains abstract concepts such as circulation system material. The results of the analysis of the needs of students and teachers on the material of the circulation system are difficult to reach students. The teaching materials developed in this study are expected to be competent in improving student learning outcomes by integrating guided inquiry learning models. This study aimed to determine the validity, practicality, and effectiveness of guided inquiry-based electronic modules. **Method:** 4D model development research. Data collection by interview and questionnaire sheet. **Result:** The module validation of the language validator is 83%, the material is 81%, the media 81% has a good category, while the learning device validator is 96%, the learning validator is 98%, and 94% has an excellent category. Practicality is taken from student responses divided into three stages: 81% preliminary trial, 89% quantitative trial, and 92% final trial showing a positive response. The effectiveness of this guided inquiry-based electronic module can improve student learning outcomes seen from the N-Gain score results. The control class is 0.38 with medium criteria, and the experimental class is 0.73 with high criteria. While the psychometric results of students who studied using guided inquiry-based electronic modules for three meetings, namely the first meeting 77% (good), the second meeting 91% (very good), and the third meeting 88% (very good). **Conclusion:** Guided inquiry-based electronic module on circulation system material has a potential effect on improving student learning outcomes.

Keywords: circulation systems; electronic modules; guided inquiry; learning outcomes.

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Introduction

In industrial era 4.0, digital transformation has an impact that causes human life to change and affects educational programs (Busthomy & Hamid, 2020). With the advancement of information technology in education, the curriculum 2013 supports science, and technology is expected to be used in every subject. (Mendikbud, 2013). Utilization of internet networks in the learning process as an addition, complement, and substitute. Students can use the internet to access new and relevant materials. In addition, students can access the material without limited time and place. Teachers must master technology, while many schools have not utilized technology (Ningsih et al., 2020).

Technology that leads to digital kites can present text, animation, video, and audio and package well in teaching material, especially in subjects containing various abstract concepts, one of which is biology (Savira et al., 2019; Sudarmo et al., 2021). Biology is a relatively broad study of various concepts of life (Ikhsan et al., 2016). The material of the circulatory system is one of the biological materials that are difficult to understand because it contains many abstract concepts (Musfiroh et al., 2012; Nurharyani et al., 2015;

Ulfa & Rozalina, 2019). The number of scientific terms of biology and discussing the mechanism of blood circulation that occurs in the body is needed good management in its presentation (Nurharyani et al., 2015).

Based on the interview results dated 18 Sept 2020, biology teachers at SMA Negeri 9 Palembang judged that the lowest value data per KD students are circulation system materials. In addition, the teaching materials used are package books and LKS and KBM plus question modules. The teacher also explained that he had developed modules that we were not delivering to students because of the limited cost of printing. To the results of questionnaires and interviews with students at SMA Negeri 9 Palembang, the modules used in KBM are not interesting for additional sources of learning, and the material is quite challenging to understand the circulation system. Providing teaching materials is a solution to improve student learning outcomes.

The important thing for learning to be effective is the presence of teaching materials. Many teaching materials, such as print and electronic modules, utilize the internet network. The advantages of electronic modules are that they are more interactive and allow the display of videos, images, youtube links, and audio (Permatasari et al., 2017; Saddhono et al., 2019). Electronic modules can be developed using sigil, flipbook, caliber, Schoology, and ePUBee maker applications. Researchers chose to use the flipbook maker application because the application can create e-books with effects such as reading real books and can be downloaded for free over the internet. In addition to teaching materials at once can display materials, images, and videos (Wijayanto & Zuhri, 2014; Wibowo & Pratiwi, 2018).

The manufacture of teaching materials that some researchers have done has been a lot, but it has not accommodated the learning model in core activities. For this reason, the teaching materials in this study combine learning models such as guided inquiry models that can improve student learning outcomes. Sarah & Ngaisah (2016) electronic model improved student learning outcomes with a score of 64% on enhancing student learning outcomes 64% after using the electronic module-based guided inquiry. In the guided inquiry model, teachers facilitate by providing instructions that guide students to solve problems so that students can solve problems on their own (Kalemben et al., 2018).

According to Natalina et al. (2013); Ambarwati (2017), after being taught using a guided inquiry model, student learning outcomes increased by 75% to 89%. The guided inquiry model makes students more interactive to think and relate the events they experience with their knowledge. The advantages of the guided inquiry model are that students can actively participate, instill attitudes, acquire knowledge and skills from the learning process, train students to solve problems, communicate and cooperate between students, and vice versa (Setiawati et al., 2013). The content of the developed electronic module will follow the syntax of the guided inquiry model.

Based on the description above, researchers develop electronic modules to improve the quality of learning. This study aims to determine the validity, practicality, and effectiveness of guided inquiry-based electronic modules on the circulation system to student learning outcomes. After creating electronic modules, the hope in the future can prepare for more effectively online and offline learning to improve student learning outcomes.

Method

Sample or Participant

The sample used was class XI students of SMA Negeri 9 Palembang, with 180 respondents consisting of 62 male students and 118 female students. This section describes the description of the sample of participants in the study.

Instrument

First, the research instrument is a questionnaire sheet with measurable indicators: language conformity, presentation media, material completeness, guided inquiry model

syntax, media, and learning methods. Each indicator has 3 to 4 questions. Second, an observation sheet to measure the psychomotor realm of students is to be observed by researchers. Third, the pretest written test is done before the learning activity, and the post-test is given after the learning activity. Students are given the same multiple-choice questions and done for 25 minutes. This electronic module will be done by the syntactic of the guided inquiry at each learning meeting activity. The following is a Figure 1 display of the module that was created.

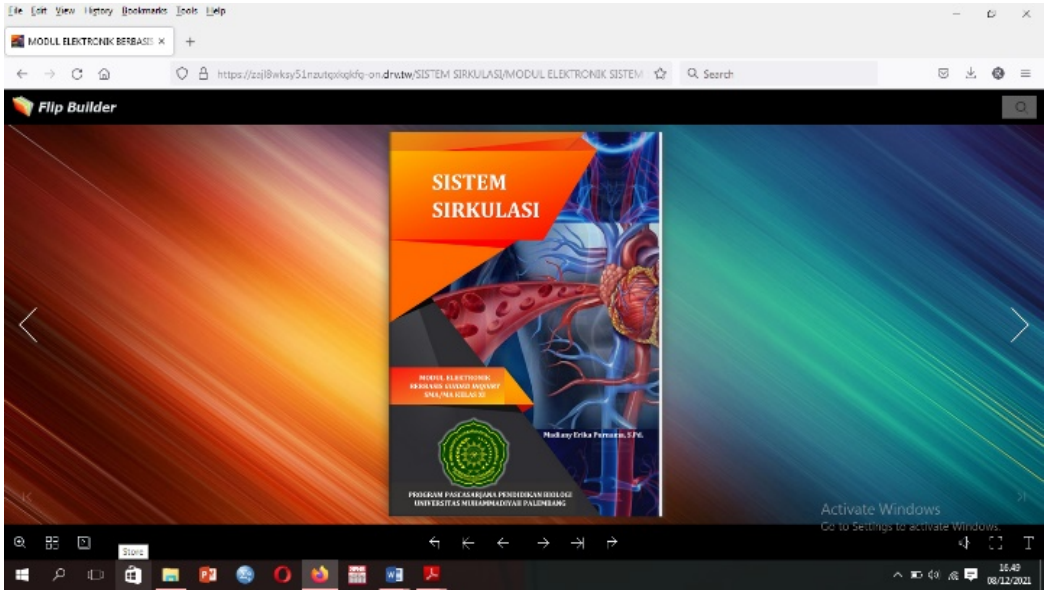

Figure 1. Electronic Module Display

Data collection and Data Analysis

Data collection is to analyze the needs of students and teachers, assessments from 6 expert validators, namely Dr. Haryadi, M.Pd. as a linguist, Sulton Nawawi, M.Pd. as a media expert, Dr. Sri Wardhani, M.Si. as a material expert, Dr. Wulandari Saputri as a learning device expert, Hepi Yulianti, S. Si., M. Si and Rama Diana, S. Pd as a learning expert, and Erie Agusta, S. Pd., M. Pd as an expert in evaluation, student response, and student learning outcomes. Data were analyzed using quantitative descriptive analysis.

Procedure

The research procedure uses the 4D Thiagarajan, S. Semmel, D. S & Semmel (1974) through 4 stages: define, design, develop, and disseminate. First, define fundamental analysis, learner analysis, task analysis, concept analysis, and objective learning analysis. Second, design is the preparation of benchmark reference tests, media selection, format selection, and initial design. Third, development is the initial product development stage that is tested for validation by expert lecturers and development trials. Fourth, dissemination is the dissemination of products that have been developed through the validity, packaging, deployment, and adoption test stages. The tools and materials used in the manufacture of this module are laptops, journal references, books on circulation systems, software, and the internet.

Electronic Module Validity Analysis Based on Guided Inquiry

The analysis was measured using the following formula by Fithriyah & As'ari (2013), and the decision-making guidelines used are listed in Table 1.

$$\mathbf{P} = \frac{\sum xi}{\sum xj} x\ \mathbf{100\ \%}$$

Table 1. Product Revision Decision-Making Guidelines

Percentage (%)	Qualification	Information
90-100	Excellent	No need to revise
75-89	Good	Revised as necessary
65-74	Enough	Pretty much-revised
55-64	Less	Revised a lot
0-54	Very lacking	Total revised

Source: Made et al. (2014)

Practical Analysis of Guided Inquiry-Based Electronic Modules

For student responses, which are calculated using the formula by Wicaksono et al. (2014):

$$\% \text{ NRS} = \frac{\sum \text{NRS}}{\text{NRS Maksimum}} \text{x } 100\ \%$$

Furthermore, to determine the criteria for the percentage value of the practicality of the electronic module, student responses per question item are in Table 2.

Table 2. Product Practicality Decision Making

Percentage (%)	Criteria
0% ≤ NRS ≤ 20%	Very weak
20% ≤ NRS ≤ 40%	Weak
40% ≤ NRS ≤ 60%	Enough
60% ≤ NRS ≤ 80%	Strong
80% ≤ NRS ≤ 100%	Very Srtong

Source: Wicaksono et al. (2014)

Analysis of Guided Inquiry-Based Electronic Module Effectiveness

Determine the effectiveness of guided inquiry-based electronic modules. It was carried out using the N-gain test according to Hake (1998) below.

$$N - Gain = \frac{\text{S post} - \text{S pre}}{\text{S maks} - \text{S pre}}$$

The results of the calculations that have been obtained are then grouped based on the following table 3 criteria:

Table 3. N-gain Value Criteria

Nilai N-gain	Criteria
N-gain ≥ 0,7	Tall
0,3 ≤ N-gain ≤ 0,7	Medium
N-gain ≤ 0,3	Low

Source: Hake (1998)

The effectiveness of the electronic module on abstract skills is calculated using the following formula, and the score criteria can be seen in Table 4.

$$\text{Optimum achievments} = \frac{\text{total score acquisition}}{\text{Maximal Score}} \text{x } 100$$

Table 4. Score Criteria for Psychomotor Learning Outcomes

Score	Information
4	Excellent
3	Good
2	Enough
1	Less

Assessment of Learning Outcomes in the psychomotor realm can be seen in Table 5 below.

Table 5. Conversion of Psychomotor Learning Outcomes and Predicate

Optimum Achievement	Letter	Category
86 – 100	A	Excellent
81 – 85	A-	
76 – 80	B+	good
71 – 75	B	
66 – 70	B-	
61 – 65	C+	Enough
56 – 60	C	
51 – 55	C-	
46 – 50	D+	Less
0 – 45	D	

Source: Mendikbud (2013)

Result

Define

It consists of 5 steps; first, the fundamental analysis gets some information that the lowest value per KD is the material of the circulatory system. The teaching materials used are LKS, package books, and modules that discuss questions. They are not colored and do not present material descriptions, so they are less interesting to use as students' independent teaching materials. The teacher also explained that he had developed a learning module that was not delivered to students because of the limited cost of printing. Therefore, the teaching materials are made with the help of technology, and the core activities will use a learning model.

Second, students like interesting teaching materials such as color displays, materials as needed, examples of events that occur in everyday life, and the existence of learning videos because they can increase students' desire to learn so that student learning outcomes will also increase. Third, the analysis of tasks to find out the required basic competency and competency standards. SK used 3 and 4 KD 3.5 and 4.5. Fourth, determine the material taught and the material chosen is the circulation system regarding the concept of blood components, understanding blood, benefits of blood, types of blood groups, understanding and function of the heart and blood vessels, various disorders and technology of the circulation system. Fifth, determining the learning objectives to be achieved based on the syllabus and RPP can be seen in Table 6.

Tabel 6. Learning Objectives

Meeting	Knowledge	Skills
First meeting	Analyzing blood components	Create a concept map of blood components and blood type through group activities
	Mentions 3 functions of blood	Present the results of group activities
	Distinguishing two blood types	
	Sorting blood transfusion mechanisms	
Second Meeting	Distinguishing the structure of heart and blood vessel function	Experimenting with calculating pulses before and after running through group activities
	Distinguishes arterial, vein, and capillary blood vessels	Create a discussion result report
	Sequencing of processes circulatory system.	
	Explains three factors that affect heart frequency	
Third Meeting	Analyzing various abnormalities of the human circulatory system	Make a summary of the three anomalies and technology of the human circulation system through group activities
	Explaining the technology of the circulatory system	Present the results of group activities

Design

The first step taken to determine the teaching material is to make a criteria test by choosing the indicator of achievement of the competition, then creating a grid of pretest and post-test questions, as many as 30 questions. The questions were validated by the evaluation expert validator, then tested the validity done in 31 students to produce 26 questions that are declared valid and reliable with Cronbach's alpha with excellent categories.

Second, the selection of teaching materials is an electronic module combined with a guided inquiry learning model. Third, the selection of the format used to make teaching materials adapted from Badan Nasional Sertifikasi Profesi (2017), of the front cover, francis sheet, identity, preface, table of contents, introduction, and instructions for using electronic modules, the syntax of guided inquiry learning model, KI and KD, concept maps, material descriptions, learning activities, student worksheets, glossary, formative evaluation, answer keys, scoring guidelines, bibliography, author's biography. Guided inquiry-based electronic module design format through flipbook maker flip pdf corporate edition.

Fourth, the product design is made according to the format that has been designed, then made through Microsoft word, then stored in pdf form. After that, make the module into electronic use flipbook maker flip pdf corporate edition application then publish in zip form. Then the application is converted via http://appsgeyser.com to be used on mobile phones and laptops. After becoming the following application, I consulted with the supervisor related to providing comments and input in terms of material, media, and language aspects. The product will be revised based on input from the supervisor and become the first draft.

Develop

Experts assessed the results of the development of the first draft, then the results of the development of the electronic module, namely the second draft, were also tested. The results of the expert assessment are Dr. Haryadi, M. Pd, as a language validator. Dr. Sri Wardhani, M. Si, as a material validator; Sulton Nawawi M. Pd, as a media validator; and Dr. Wulandari Saputri, M. Si. and biology teachers as learning validators. Description of the assessment results from experts in Table 7 next.

Tabel 7. Expert Assessment

Expert Assessment	Achievement (%)	Qualification	Description
Language	83	Good	Revised as necessary
Material	81	Good	Revised as necessary
Media	81	Good	Revised as necessary
learning devices	96	Excellent	No need to revise
Learning	98	Excellent	No need to revise
	94	Excellent	No need to revise

Table 7 gives an idea that the electronic module based on guided inquiry of the circulation system materials developed is valid and feasible. However, some improvements need to be made, including:

- Improvement of writing on material descriptions and biological terms
- Changes in background images that are too bright
- Image repair with English captions translated to Indonesian

In the next stage, students fill out a questionnaire sheet containing question questions from the indicators of material, language, and image control in the module, presentation of materials, and infographics of modules aimed at knowing whether this module provides new knowledge, ease of use, and is worth disseminating. This stage is divided into three activities carried out by students of class XII MIPA 1 SMA Negeri 9 Palembang as

respondents, namely: 1) preliminary trials (3 students who have medium, high, and low abilities); 2) quantitative trials (12 students); 3) Final trial (25 students). The results of the development trial analysis are presented in the following table 8.

Table 8. Development result Testing

Testing Stage	∑ NRS	∑ Maks	% NRS	Response
Preliminary trial	146	180	81	Very Strong
Quantitative trial	640	720	89	Very Strong
Final trial	1375	1500	92	Very Strong

The results of the development in the preliminary trial stage (81%), quantitative trials (90%) with a powerful response, and the final test student response increased very strongly (92%). After analyzing the results of development trials, there are still several suggestions, one of which must be improved, such as the size of the application being too large so that the phone's memory is full and there are difficulties when installing the application.

Input from the electronic module expert in the form of an application is converted into html5 by republishing it to html5-only. To be accessible, the folder containing the raw materials for this electronic module is uploaded to Google Drive, then the following link can be accessed by all students: https://s.id/modulesistemcirculation.

Disseminate

The implementation of learning using guided inquiry-based electronic modules was conducted by 36 students in class XI MIPA 1 as a control class that did not utilize electronic modules and 36 students of class XI MIPA 5 as an experimental class using electronic modules. Researchers conducted activities in the two classes for 3 x 45 and three meetings per class. The results of the analysis in Table 9 are below.

Table 9. N-Gain Analysis Results of Control Classes and Experiment Classes

Class	Pre test	Post test	*N-Gain Value*	Criteria
XI MIPA 1	43,3	64,8	0,38	Medium
XI MIPA 5	46,9	85,5	0,73	High

The n-gain value of the experimental class is higher than that of the control class. The average learning outcome of experimental class students was 85.2, and the middle control class was 64.2, with a higher experimental class standard deviation of 8.36 and a standard deviation of the control class of 8.21. The achievement of complete learning outcomes of students who use the guided inquiry-free electronic module reaches 85%.

Psychomotor learning outcomes of students using observation sheets were supervised and assessed by researchers at the 1st, 2nd, and 3rd meetings. The results of the observations can be seen in Table 10 below.

Table 10. Student Learning Outcomes of the Psychomotor Realm

Meeting	Psychomotor Values	Achievement (%)	Categories
1 (Creating a Concept Map)	Keywords	81	Excellent
	Branch relationship with others	73	Good
	Color Design	81	Excellent
	Material completeness	75	Good
	Draw conclusions	76	Good
2 (Pulse Counting Experiment)	Designing Experiment	89	Excellent
	Making a test result report	100	Excellent
	Draw conclusions	85	Excellent
3 (Making summary)	Substransi	98	Excellent
	Language	83	Excellent

Aesthetics	77	Good
Material completeness	96	Excellent

Changes in the form of html5 establish guided inquiry-based electronic modules. Furthermore, it is disseminated through class Whatapps groups to access each student so that it can be absorbed (diffuse), understood, and used (adopted) by teachers and students. Guided inquiry-based electronic modules that have gone through the trial and subsequent improvement stages are disseminated to high school Biology teachers.

Discussion

The Validity of Electronic Modules Based on Guided Inquiry

The validation results of the guided inquiry-based electronic module were tested through an expert appraisal stage by the language validator, material validator, media validator, learning device validator, and learning validator. There are several indicators to assess the guided inquiry-based electronic module. The results of the experts' assessment obtained data, namely the results of validation of linguists obtained an average value of all indicators of 83% good qualifications and revised as necessary. The results of the material expert validation received an average score of all indicators of 81% good qualifications and revised as necessary. Then the electronic module validated by the media expert obtained the average value of all indicators of 81% good qualification and revised as necessary. There are some improvements regarding product lack in the design and readability of electronic modules.

The validator of the learning device obtained an average score of all indicators of 96% excellent qualifications and did not need to be revised. Furthermore, two teachers as learning validators, namely teacher 1, obtained an average score of all indicators of 98% and teacher 2 94%, both of which are excellent qualifications and do not need to be revised. Validation of learning device experts and electronic module learning experts is worthy of trial, and researchers must still make improvements despite excellent qualifications. According to Ardiansyah (2020) teaching materials are declared valid and can be used if they get a percentage rate of 81 to 100% after validation by experts. Then, trials can be carried out.

Based on the results of the validation of experts, it can be concluded that the module is very feasible for use. The characteristics of electronic modules are worth using, including 1) *Selft instructional,* which contains clear learning objectives, the existence of actual examples that can support material clarity, problem exercises and scoring guidelines to measure students' abilities, the language used simple and easy to understand, summary and feedback so that students can measure the level of understanding; 2) *Selft contained*, core competencies and KD circulation system materials are studied in one intact electronic module; 3) stand-alone, with this electronic module does not have to involve other teaching materials; 4) adaptive, electronic modules developed have been adapted to the development of science and technology; and 5) user-friendly, every Instructions for use are helpful to students, use simple language, and use commonly used terms (One, 2017).

The practicality of Guided Inquiry-Based Electronic Modules

The practicality of guided inquiry-based electronic modules can be seen in table 7. which shows that the average grade is increasing at each stage, meaning that the > 50% of the student's prescriptions are positive. The overall indicators in the category are powerful. Practicality is also seen from the comments and suggestions of teachers as learning experts who are fairly positive. The student's response in question is the interest and response of students to the guided inquiry-based electronic module. By spreading questionnaires through google Forms to students, researchers can find out the students' responses can be seen in table 8.

According to Setiawati et al. (2017), a powerful student response is a positive response obtained if the indicators in the student response questionnaire show more than 50% so that the teaching material is said to be worth using. The advantages of electronic modules based on guided inquiry of circulation system materials are 1) equipped with instructions for use, group discussion tasks, YouTube links related to circulation system materials, student worksheets, summaries, formative evaluations, and feedback that makes it easier for students to measure their abilities; 2) this module is electronic in shape making it easier for students to read and carry it anywhere; 3) the cover of the module and the image related to the material of the color circulation system and attract the attention of students to read it.

Effectiveness of Electronic Modules Based on Guided Inquiry Circulation System Materials to Improve Student Learning Outcomes

Effectiveness is based on the presence or absence of increased student learning outcomes in the form of cognitive and psychomotor values. Effectiveness is also seen in the significant data differences between control and experimental classes that apply guided inquiry-based electronic modules in learning activities. N-gain testing was conducted taken from pretest and post-test scores to measure the increase in student learning outcomes.

The N-gain score results showed a difference in post-test values between control classes that did not use guided inquiry-based electronic modules taught online via telegram of 0.38 with medium criteria. In contrast, the experimental class used guided inquiry-based electronic modules led online through Microsoft Team media with a high N-gain score of 0.73 criteria. Based on these values, it can be concluded that there is an increase in student learning outcomes by using guided inquiry-based electronic modules.

These electronic modules are systematically organized based on KD, learning objectives, materials, learning activities, student worksheets, evaluations, and scoring guidelines that can help students measure their learning abilities independently. In addition, learning activities are adjusted to the syntax of the guided inquiry learning model, namely: 1) problem orientation, 2) data collection and verification, 3) data collection through experimentation, 4) organization and formulation of explanation, and 5) analysis of the inquiry process.

The value of the psychomotor aspect is measured using an observation sheet and then analyzed with optimum achievement testing. The psychomotor assessment aims to determine students' psychomotor ability during the learning process. The psychomotor results of students who learned to use guided inquiry-based electronic modules during 3 meetings can be seen in Table 10, the good and excellent category. There is an increase in each meeting. In the guided inquiry model syntax, there are stages students must be able to conclude the results of group discussions, present, teachers provide feedback, and if there are mistakes, students must make improvements. The product is said to be effective if the value of > 70% of its users indicates the ability to use the product (Hertiavi, 2017).

At each meeting in the guided inquiry-based electronic module, there is a step of collecting data through experiments as a psychomotor score capture of students. In this guided inquiry-based electronic module, there are steps to collect data through experiments, such as taking students' psychomotor scores. In the first meeting, each group was given the task of making a concept map and presenting it. Each group counted the pulse after and before running in the second meeting and reported the experiment results, and this is in line with Bilgin (2009) research, which states that guided inquiry activities help students become proficient in making reports. In the third meeting, each group summarized three types of disorders of the human circulatory system and technologies related to the circulatory system. The guided inquiry-based electronic module effectively measures the improvement of students' psychomotor scores.

The obstacle to this research is obtaining software that can be used to do electronic modules. Cheva & Zainul (2019) e-modules have very high validity and a very high level of

practicality. In line with research, Permatasari et al. (2017) stated that the validity results of e-modules were classified as valid at 84.66, efficient at 91.11%, and high the average value of N-gain is 0.71.

Conclusions

The validity of electronic modules is tested with expert assessment by language, material, and media validators with suitable qualifications. In contrast, the results of the learning device validator are very qualified and very suitable for use. The practicality of the electronic module based on guided inquiry of circulation system materials can be seen from the results of development trials with three stages: preliminary, quantitative, and final, which shows a powerful and positive response and comments and suggestions given by students. Electronic modules based on guided inquiry of circulation system materials can improve student learning outcomes compared to control classes judging from N-Gain scores, control class 0.38 with medium criteria, and experimental class 0.73 with high criteria. At the same time, the psychometric results of students who learned to use guided inquiry-based electronic modules for three meetings were categorized as good and excellent. Products in electronic modules can be further developed using other learning models such as problem-based learning and project-based learning. Applications used to create electronic modules can use more innovative software such as sigil, ePUBee maker, or caliber.

Declaration statement

The authors reported no potential conflict of interest.

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