



Development of Process Oriented Guided Inquiry Learning-based E-Module to Improve Critical Thinking Skill

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Abstract: This study aims to determine the feasibility of a POGIL-based e-module to empower students' critical thinking skills. The type of research used is research and development with research procedures using ADDIE (Analysis, Design, Development Implementation, Evaluation) model development. This research is limited to the feasibility test of POGIL-based e-modules at the development stage. The assessment of the validity test results and the questionnaire practicality test were interpreted on a Likert scale. Based on data analysis, the following results were obtained: validity tests by POGIL-based e-module learning media obtained an average of 88.3% for media validity; 96.6% for the validity of the material; and 87.5% for Language validity. Practicality tests conducted by teachers get an average of 84% and students by 90.6%. Based on the validity and practicality test of POGIL-based e-module learning media to empower students' critical thinking skills, they are declared feasible to be used for further research.

Keywords: E-Module; POGIL; Critical thinking skill

Introduction

21st-century knowledge skills is learning and innovation skills (Trilling & Fadel, 2009). Learning and innovation skills include creativity, collaboration, communication, problem-solving, and critical thinking (Lu & Xie, 2019). Critical thinking skills are the ability of students to express reasons both orally and in writing (Živkovič, 2016). Critical thinking skills have six components: interpretation, analysis, inference, evaluation, explanation, and self-regulation (Facione, 2015).

Critical thinking skills are competencies that students need for personal and professional life. Critical thinking is a process, as well as its acquisition takes time. In this process, teachers must realize the need for transformations to adapt their teaching methodology to their students' learning (Bezanilla et al., 2019). Think critically about building arguments and influencing life and the future (Ravista et al., 2021). Critical thinking is a process that is contextual and manifested through a pedagogical context (Danvers, 2019). Dekker (2020) also states that students' critical thinking skills often assume each discipline reveals in various aspects of the possible

solution to the problem and produces the complete answers necessary to combine all these insights. Critical thinking students develop the idea that the truth or explanation of a problem cannot always be well explained from one particular perspective (Utami et al., 2022).

The PISA (Programme for International Student Assessment) study in 2018 showed that Indonesia ranked 71st out of 79 countries. PISA evaluation includes performance in reading, science as well as mathematics. Assessment of the potential performance of science years obtained an average score of 396, so it decreased higher in 2015 by obtaining an average score of 403. Students can clearly understand scientific phenomena that occur. From understanding knowledge, it will be used as an identification, in a general case, in the assessment of scientific performance ability. The low results of the survey from PISA in 2018 show that there must be a review and improvement of education in Indonesia that can compete to improve quality to be able to face directly with obstacles that occur in the 21st century. The results show that there is still a low level of high-level skills among students, especially the level of critical thinking of students in Indonesia.

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Critical thinking is a process, and its acquisition takes time. In this process, teachers must realize the need for transformations to adapt their teaching methodology to their students' learning (Bezanilla, M. J., Fernández-Nogueira, D., Poblete, M., 2019). The use of learning models can help adjust teaching methodology. One learning model that can accommodate critical thinking skills is POGIL (Process Oriented Guided Inquiry Learning). The POGIL model is based on the principle of constructivism that can make students more active with the existence of group interactives as problem-solving (Syafei & Mawardi, 2022). POGIL is teaching that focuses on students by doing it in groups aimed at mastering a concept of non-memorization. Students are also expected to improve assessment, management, teamwork, communication, metacognition, high-level thinking, and critical thinking skills (Hanson, 2006).

In addition, the way to improve critical thinking skills is to develop teaching materials such as electronic e-modules (e-modules) (Pierce & de Man, 2019; Rajaguru et al., 2020; Wahidah et al., 2019). E-modules have strategic value in practicing critical thinking skills. Pierce & de Man (2019) states that critical thinking in biology learning can be developed using literature in the form of e-modules.

Based on the background of the problem and the results of preliminary observations, researchers developed a POGIL-based e-module learning media to empower students' critical thinking skills.

Method

This research is a research and development. The basis for the development of this research uses the ADDIE model owned by Branch (2009). The ADDIE model consists of five stages: analysis, design, development, implementation, and evaluation (Branch, 2009). However, this publication is limited to the analysis, design, and development stages. The ADDIE model can be viewed in Figure 1.

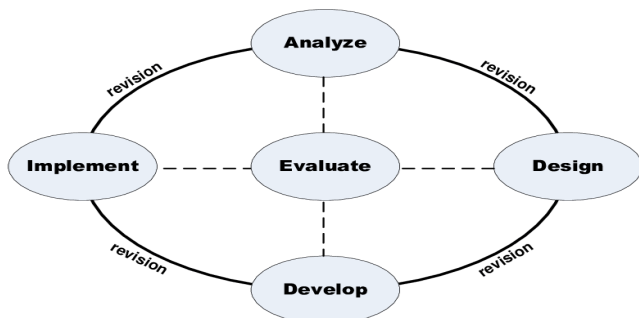


Figure 1. ADDIE Model

This study consists of two types of data: qualitative and quantitative. Qualitative data is obtained through the analysis and design stages. The first stage is analysis, qualitative data obtained by literature review, reviewing

learning tools, analyzing teacher needs, and analyzing student needs. In the second stage of design, qualitative data is received by compiling the design of student activities, compiling learning objectives, compiling instruments for critical thinking skills test questions, and compiling the initial framework of the e-module. Qualitative data objectives are collected to compile a specification of research objectives and make a preliminary design of the development product.

Quantitative data is obtained through the development stage with expert and practitioner validation. Data from expert and practitioner validations are used for the results of the feasibility test of the development product. Expert validation consists of three validators: media, material, and language expert validators. Practitioner validation consists of two validators: the biology teacher and the student as the use. The data obtained from the results of the validity test and practicality test are then analyzed using formula 1.

$$P = \frac{\sum Xi}{\sum X} \times 100\% \tag{1}$$

P = Ranking percentage
 $\sum Xi$ = Scores given by expert validators
 $\sum X$ = Maximum Score

The overall feasibility percentage results of the components used for decision-making are whether or not they are suitable for use in POGIL-based e-module learning media. The decision-making categories of validity tests and practicality tests can be seen in Table 1.

Table 1. Likert scale interpretation

Score %	Category
0 - 25	Bad
26 - 50	Not Good Enough
51 - 75	Good
76 - 100	Excellent

The validity test in this study consists of media experts, material experts, and linguists. The aspects assessed in the validity test to media experts are program guide, program purpose, interface, and wear and durability. The aspects assessed in the validity test to the material expert are introduction of E-Module, learning, content, evaluation, and additional part. The aspects assessed in the validity test for linguists are correct, terminology, clarity, and. Suitability.

The Practicality Test in this study was aimed at teachers and students to respond to the development of POGIL-based e-module media. The aspects assessed in the teacher practicality test are convenience, interest and motivation, self-learning, critical thinking and problem solving, and contextuality. The aspects assessed in the

student practicality test are organization, legibility, attractiveness, cohesiveness, and critical thinking.

Result and Discussion

Based on the initial needs analysis, the learning media commonly used by teachers are not supportive of empowering students' critical thinking skills. Teachers only use videos and PowerPoint as learning media. The results of the analysis of teaching materials that teachers use include print modules and textbooks, showing that both are compiled in general and do not contain the steps for implementing a learning model. In addition, the results of the analysis also show that both modules and books have not been empowered to practice critical thinking skills.

In the learning process, teachers have not applied e-modules to students, and a POGIL (Process Oriented Guided Inquiry Learning) based teaching model because there are obstacles in this learning model. It is difficult to stimulate student activities; not all students are active. In POGIL, student-focused teaching that invites students to be more involved in learning activities and investigate more deeply about a topic.

Based on the initial needs analysis, the researchers carried out the development of a POGIL-based e-module. The POGIL-based e-module aims to empower students' critical thinking skills. The material contained in the e-module is adjusted based on the syntax of the POGIL learning model.

Development is carried out using tools in the form of software and hardware. The software used is Visual Studio Code version 1.167.1 and Corel Draw version X7. The hardware is a laptop with an Intel Core i5 5th Gen CPU processor @ 1.60 GHz 2.30 GHz, 4GB RAM, Android smartphones, and IOS.

POGIL-based e-module learning media comprises front pages, introductions, about, competencies, instructions for use, concept maps, learning activity menus, POGIL learning syntax, orientation, exploration, concept formation, application, and credit. The front page contains student information to log in to the e-module feature. The front page of the POGIL-based e-module can be viewed in Figure 2.

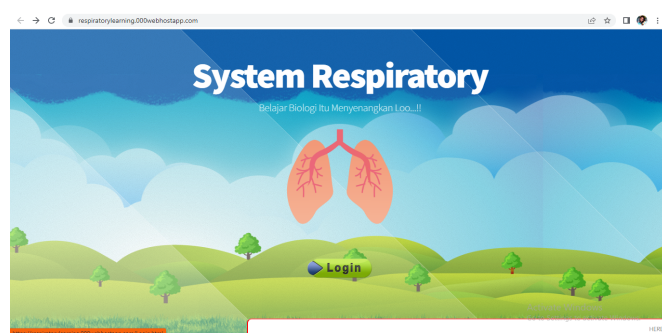


Figure 2. Home Page

The introductory page contains a brief explanation of the POGIL-based e-module. The initial page can be seen in Figure 3.

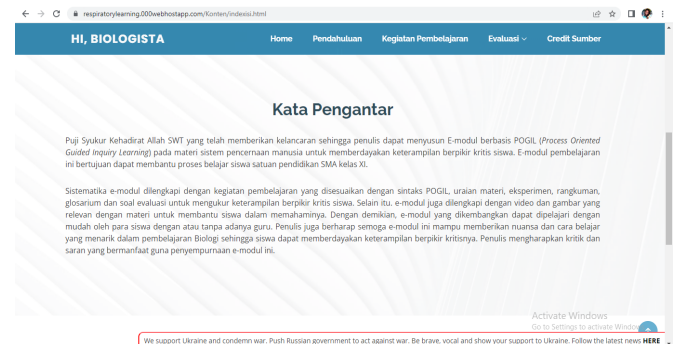


Figure 3. Initial Page

The about page contains a brief description of the material and parts of the e-module. The about page can be seen in Figure 4.



Figure 4. About Page

The Competency page explains the core competencies and basic competencies according to the 2013 curriculum. The competency page can be viewed in Figure 5.

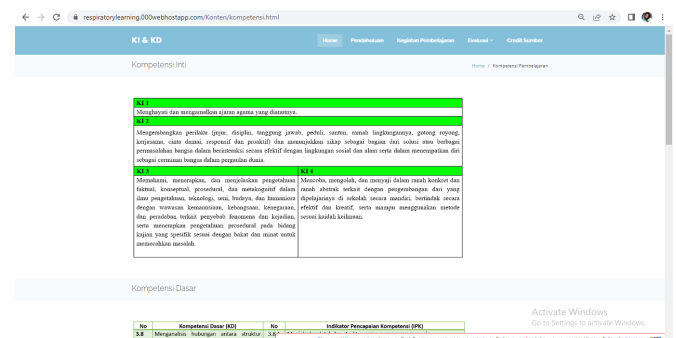


Figure 5. Competency Page

The e-module usage instructions page is listed at the beginning to make it easier for users to operate the e-module. The instructions for the use page can be seen in Figure 6.



Figure 6. User Instructions Page

The concept map page summarizes the material presented in the e-module based on the 2013 curriculum. The concept map page can be seen in Figure 7.

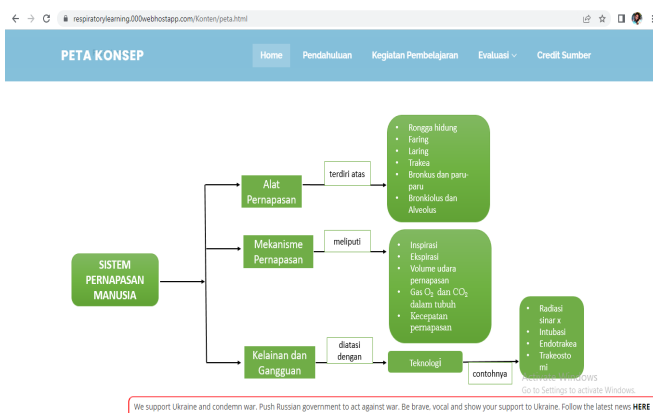


Figure 7. Concept Map page

The learning activities menu page contains sub-materials that will be studied in one chapter taught. The learning activities menu page can be seen in Figure 8.



Figure 8. Learning Activities Page

The POGIL learning syntax page consists of orientation, exploration, concept formation, application, cover, and material. The POGIL learning syntax page can be seen in Figure 9.



Figure 9. POGIL Learning Information Page

The orientation page contains the problems presented to realize a responsive learning situation. The orientation page can be seen in Figure 10.



Figure 10. Page Orientation

The exploitation page contains the formulation of the problem based on the issue presented in the orientation section. The exploration page can be viewed in Figure 11.



Figure 11. Explorations Page

The concept formation page demands that students conclude precisely, assisted by the questions presented. The concept formation page can be seen in Figure 12.

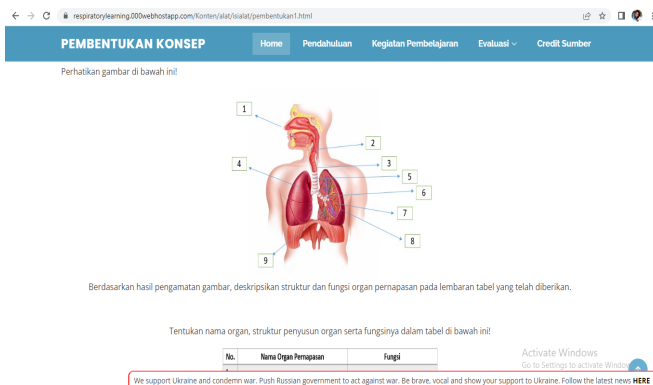


Figure 12. Concept Formation Page

The application page is a reinforcement of the concepts that have been compiled previously. The application page can be seen in Figure 13.

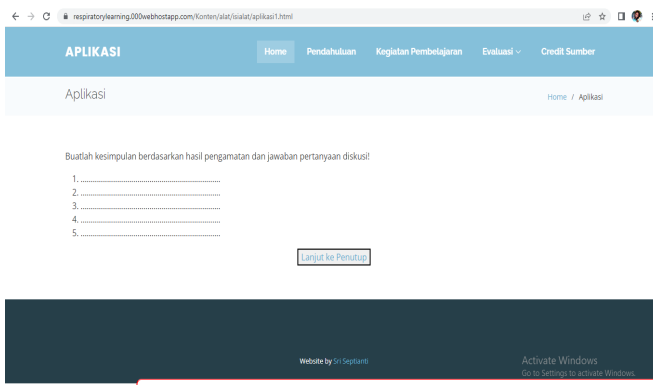


Figure 13. Application Page

The closing page reflects the discussion results in the previous stages, which an evaluation from the teacher will assist. The closing page can be seen in Figure 14.

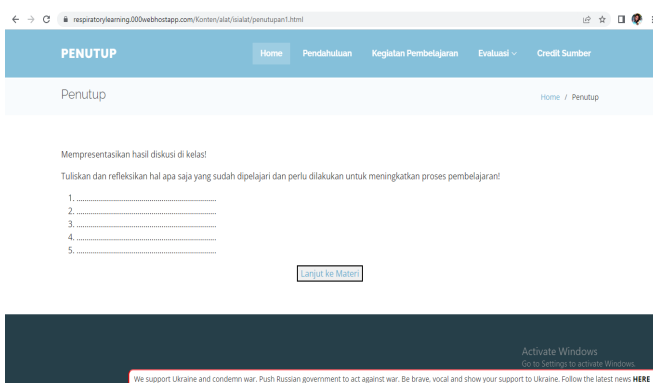


Figure 14. Closing Page

The material page contains a summary of the material of the sub-material studied for each learning activity. The material page can be seen in Figure 15.



Figure 15. Material Page

The credits page contains a bibliography and glossary that users can use to obtain additional information appropriate to the material. The credit page can be seen in Figure 16.

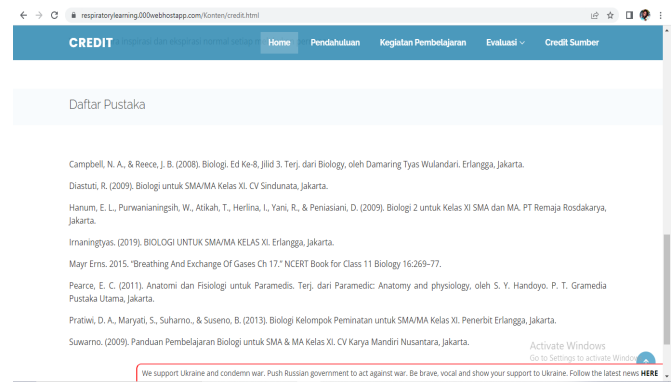


Figure 16. Credit Page

One of the tools in the learning process is learning media (Hartini et al., 2017), and learning must-have media innovations that keep up with the times (Mukhadis et al., 2021). One of media is web-based e-module (Hendri et al., 2021). Each individual must currently have the literacy of mastering information technology, information literacy, knowledge and literacy skills of digital, and critical thinking skills (Lu & Xie, 2019). Thus, learning media are needed to accommodate the essential empowerment of thinking skills. In addition, the way to improve critical thinking skills is to develop teaching materials such as electronic e-modules (e-modules) (Pierce & de Man, 2019; Rajaguru et al., 2020; Wahidah et al., 2019).

The validity test of media experts consists of four aspects, namely program guide, program purpose, interface, wear, and durability. The results of the media validity test can be seen in Figure 17.

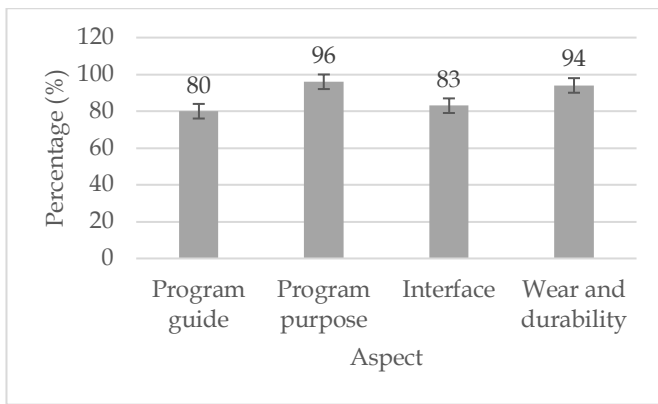


Figure 17. Media Validity Test Results

Based on the validity test results above, POGIL-based e-module learning media received 80% results in the program guide aspect, 96% in the purpose program aspect, 83% in the interface aspect, and 94% in the wear and durability aspect. The overall average of the measured aspects reached 88.3%, with the excellent category. The media validity test is declared valid after testing by a media expert (Badu et al., 2021). A media expert is a person who has the capacity for media development (Astuti et al., 2022).

The material is the main component of the teaching material (Giguère et al., 2020). The material listed on the learning media is the main part of forming student knowledge (Gess-Newsome, 2015). The material in this POGIL-based e-module is arranged based on the sequence and steps of learning the POGIL syntax. POGIL's learning sequence includes five stages: orientation, exploration, concept formation, application, and closing (Hanson, 2010).

The material expert validity test consists of five aspects: introduction, learning, content, evaluation, and additional parts assessed by material expert validators. Material expert validators are selected based on their capacity as lecturers who are experts in the material of the human respiratory system. The results of the material validity test can be seen in Figure 18.

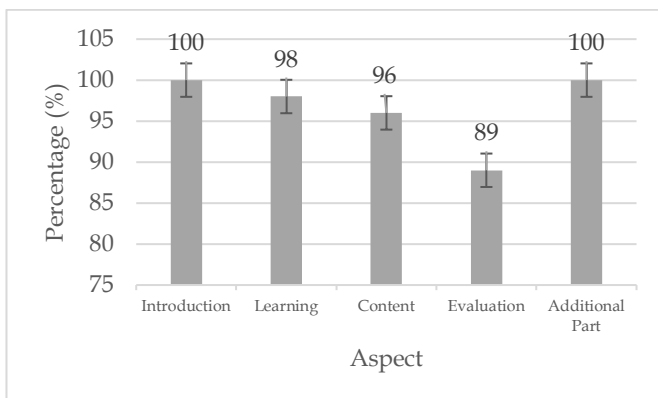


Figure 18. Material Validity Test Results

Based on the results of the validity test above, the material listed on the POGIL-based e-module learning media received 100% results in the introduction aspect, 98% in the learning aspect, 96% in the content element, 89% in the evaluation, and 100% in the additional part aspect. The overall average of the measured aspects reached 96.6%, with the excellent category. The material validity test is declared valid after testing by a material expert.

Language is one of the ways of delivery used in e-modules (Sofyan et al., 2019). The language in learning must be by the material being taught (Berardo, 2006). Language Usability is the main tool when e-modules are used as self-study advice (Kossioni et al., 2013).

The language expert validity test consists of four aspects: correct, terminology, clarity, and suitability, which the linguist validator assesses. The results of the language validity test can be seen in Figure 19.

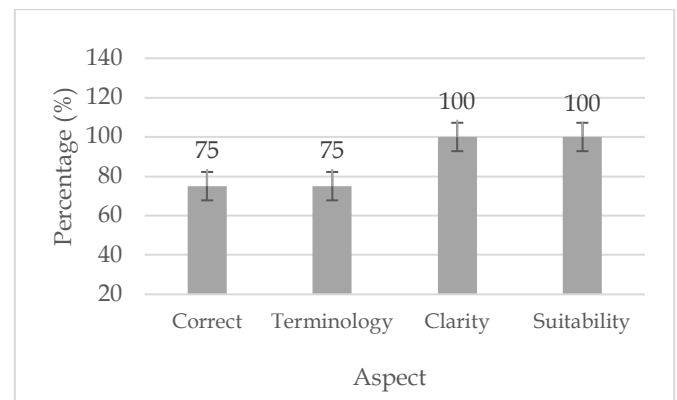


Figure 19. Language Validity Test Results

Based on the validity test results above, the delivery language used in POGIL-based e-module learning media received 75% results in the correct aspect, 75% in the terminology aspect, 100% in the clarity aspect, and 100% in suitability. The overall average of the measured aspects reached 87.5%, with the excellent category. The Language validity test is declared valid after testing by a linguist.

The presentation of the POGIL-based e-module developed has met the criteria. Based on the validity test of media, materials, and languages, it is feasible with several revisions to be continued at the practitioner test stage.

The practitioner test stage is carried out to obtain the practicality value of POGIL-based e-module media. The teacher's practicality test consists of six aspects, namely convenience, interest, self-learning, critical thinking, contextuality, and accuracy. Two biology teachers conducted the teacher's practicality test. The teacher's practicality test results can be seen in Figure 20.

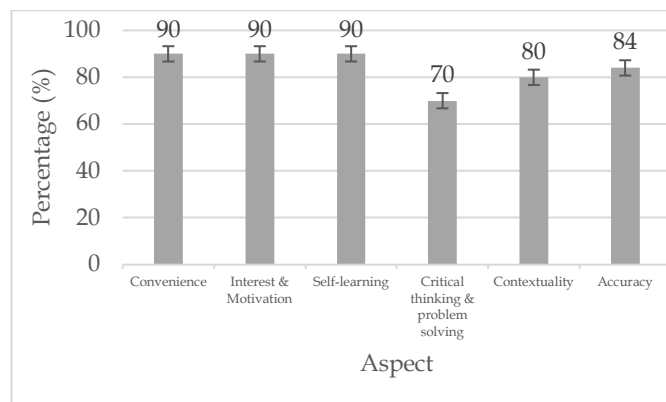


Figure 20. Teacher Practicality Test Results

Based on the results of the teacher practicality test above, the test response to teachers reached 90% in the convenience aspect, 90% in the interesting aspect, 90% in the self-learning aspect, 70% in the critical thinking aspect, 80% in the contextuality aspect, and 84% in the accuracy aspect. The overall average of the measured aspects reached 84%, with an excellent category.

The student practicality test consists of five perspectives: organization, legibility, attractiveness, cohesiveness, and critical thinking. The practicality test of students is carried out by a small group of students who pilot POGIL-based e-module development products. The results of the practicality test can be seen in Figure 21.

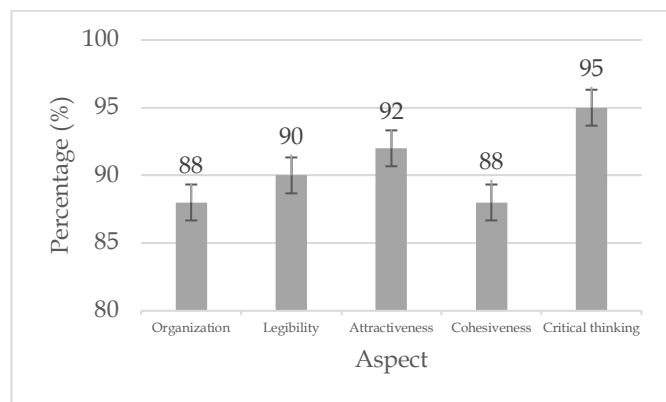


Figure 21. Student Practicality Test Results

Based on the results of the practicality test of the students above, the response of small field trials reached 88% in the organization aspect, 90% in the legibility aspect, 92% in the attractiveness aspect, 88% in the cohesiveness aspect, and 95% in the critical thinking aspect. The overall average of the measured aspects reached 90.6%, with the excellent category.

The validity and practicality tests that have been carried out obtained an excellent category average. So, it is declared valid and practical to use in further research.

Conclusion

The validity test conducted for POGIL-based e-module learning media obtained an average of 88.3% for media validity, 96.6% for the validity of the material, and 87.5% for Language validity. Practicality tests conducted by teachers get an average of 84% and students by 90.6%. Based on the validity and practicality tests that researchers have carried out, POGIL-based e-module learning media products to empower students' critical thinking skills are declared feasible to be used for further research.

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