

Needs Analysis for Developing PjBL-STEM-Based *E-Modules* on the Circulatory System to Enhance Critical Thinking Skills

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Abstract: Critical thinking has become an intrinsic part of our lives in educational as well a professional field while moving to 21st alongside, it is essential for progression. While integration of more advanced material into secondary education may be one step in right direction, schools must also need to better prepare their students for the diverse social lives and increasingly competitive economic landscapes—and workplaces that inherently require higher degreeing-of than before. The PjBL (Project-Based Learning) model combined with STEM provides students real and relevant science concept-building layered on technology, engineering, mathematics skill development. Based on the above background, e-module development steps need to begin with needs assessment for teachers and students in PjBL-STEM. This study describes the results of a needs analysis for PjBL-STEM e-module development. This research subjects are 11th-grade of biology teacher and students at the government high school where comprise SMAN 1 Dagangan. This descriptive research using questionnaires and instruments are created based on aspects of critical thinking skills. The result of the study found that (1) learning still has not used e-module, and (2) needs to be developed PjBL-STEM-based e-modules to improve students' critical thinking skills.

Keywords: critical thinking skills, e-module development, needs analysis, PjBL STEM (science tchnology engineering mathematics)

1. INTRODUCTION

The development of critical thinking as an essential skill in 21st-century learning is undeniable in both educational and professional environments. Critical thinking skills refer to an individual's ability to actively analyze, evaluate, and synthesize information in a rational and logical manner (Heard et al., 2020). Teachers are expected to guide and support students' readiness for production, curiosity, problem-solving skills, and critical thinking. Additionally, students need to be equipped with skills such as communication, collaboration, problem-solving, and productivity (Kuloglu & Karabekmez, 2022). A student may not be prepared to play a role in society if they are not trained in critical thinking skills, making them less capable of contributing positively to their own development and leading them to become less productive and competitive members of society (Aulia, 2022).

Preliminary research conducted by the researcher using critical thinking skills instruments shows that students' critical thinking skills indicate only two aspects that meet the "satisfactory" criteria: providing explanations at 52% and organizing strategies and tactics at 56%. Meanwhile, the other three aspects fall under the "needs improvement" criteria: drawing conclusions at 43%, giving further explanations at 32%, and building basic skills at 20%.

The results of the Biology Subject Teacher Conference (MGMPs) at SMAN 1 Dagangan revealed that the learning materials developed according to the "Merdeka" curriculum still have several learning outcomes that are not well-structured. The teaching model and methods used are one-directional, and students tend to be passive during lessons (teacher-centered). Teachers have not made good use of IT, with commonly used media being PowerPoint and YouTube videos. The teaching materials at SMAN 1 Dagangan consist of textbooks from several publishers and teaching modules, but both do not meet the technical guidelines for book or module development and do not reflect a particular learning model. The analysis also indicates that these textbooks and teaching modules have not been specifically designed to train students' critical thinking skills. In interviews, biology teachers stated that they had never created or used PjBL-STEM-based e-modules. The reason for this is that teachers are unfamiliar with how to create e-modules integrated with specific learning models, such as PjBL-STEM-based e-modules. Teachers also expressed a lack of confidence in using e-modules, citing difficulties in encouraging student engagement. Regarding the topic of the circulatory system, students' ability to grasp the concepts is still lacking due to the complexity of the material, which highlights the need for learning media such as e-modules to assist students in mastering the concepts.

Project-based learning (PjBL) is one of the constructivist teaching strategies in science education considered important (Issa & Khataibeh, 2021). Chiu (2020) explains that PjBL is a group-based learning approach where

students are faced with real-world problems and practices. PjBL is an educational methodology that can enhance communication skills and critical thinking (Cortázar et al., 2021).

The STEM approach integrates science, technology, engineering, and mathematics in learning (Sarwi et al., 2021). STEM learning makes education relevant and meaningful, which in turn can improve students' critical thinking skills (Adhelacahya et al., 2023). The PjBL-STEM integrated learning model provides authentic and contextual experiences in education, allowing students to build scientific concepts, technological skills, engineering abilities, and mathematical knowledge (Wan et al., 2022). Therefore, the PjBL-STEM model is considered more effective in learning. It allows students to explore and engage actively with real-world challenges to gain a deeper understanding (Agustin et al., 2023).

The circulatory system material consists of several complex subtopics, including the structure and function of the circulatory system, the mechanisms of the circulatory system, disorders and diseases related to the circulatory system, and technological applications associated with it (Rusdi et al., 2022). PjBL-STEM-based e-modules can be used as a medium to facilitate teachers in delivering circulatory system material to students and to enhance students' critical thinking skills.

2. METHODS

The research employed a descriptive quantitative approach. Data was collected by distributing questionnaires to both teachers and students. The data collection involved teachers and 11th-grade students in Phase F of the Merdeka Curriculum at SMAN 1 Dagangan. The questionnaire for teachers aimed to gather information about the teaching process, the use of instructional materials, learning media, and the application of the PjBL-STEM learning model. On the other hand, the student questionnaire was designed to describe their learning experiences, the media used by their teachers, the use of PjBL-STEM-based e-modules in the lessons, and their expectations for learning tools that could help make studying biology easier. In addition to the questionnaires, students were given a test to assess their initial critical thinking skills.

3. RESULTS AND DISCUSSION

3.1. Questionnaire and Interview

The research findings were gathered through interviews with teachers and by distributing questionnaires to both teachers and students. Interviews were conducted with the 11th-grade biology teacher and 50 students from the 11th grade (Phase F) at SMAN 1 Dagangan. These interviews were held in person, where questions were posed to the teacher. The responses focused on the teaching process, the teaching materials used, and the learning media employed by the teacher.

Based on the results of the teacher needs analysis questionnaire, it was found that the teacher had never developed or used the PjBL-STEM learning model. The teacher explained that the reason for not using this type of module was the difficulty in creating e-modules integrated with a specific learning model, such as PjBL-STEM. Additionally, the teacher expressed a lack of confidence in using e-modules due to challenges in encouraging active student participation.

The teaching materials used at SMAN 1 Dagangan consist of textbooks from various publishers and teaching modules. However, both have been found not to fully adhere to the technical guidelines for book or module development, nor do they reflect any particular learning model. The analysis further revealed that these textbooks and modules were not specifically designed to develop students' critical thinking skills. The teaching methods predominantly follow a one-way, teacher-centered approach, where students remain passive during the learning process. Moreover, the teacher has not made optimal use of IT, with PowerPoint presentations and YouTube videos being the most frequently used teaching tools. During the learning process, the teacher has used student worksheets (LKPD) downloaded from websites, but observations indicate that students show little interest in biology lessons. They tend to be noisy, with the teacher taking on a more active role. Students reported that biology lessons were not particularly engaging, which often made them feel bored.

The teacher expressed a desire for more engaging learning media that could help students better understand the material on the human circulatory system, including materials aligned with student learning indicators, practical simulations, and project-based assignments. Abstract biology concepts are often difficult for students to grasp, as they typically rely only on theory without direct observation or hands-on experiences. The evaluation of student learning currently covers cognitive, affective, and psychomotor aspects. However, cognitive tests primarily measure remembering, understanding, and applying, with less emphasis on analyzing, evaluating, and creating. As a result, students' critical thinking skills have yet to be fully developed.

3.2. Tabel dan Gambar



Based on the questionnaire results from the needs analysis involving 34 11th-grade students at SMAN 1 Dagangan, the data is presented in Table 1.

Table 1. Results of Student Needs Analysis

| No | Question | answer choices (%) | |
|----|---|--------------------|-------|
| | | Yes | No |
| 1 | Do you have textbooks to study biology material?? | 100% | 0% |
| 2 | Do you also study from sources other than books at school to help you understand biology material?? | 97,4% | 2,6% |
| 3 | Are you having difficulty studying the biology material in the book?? | 61,6% | 38,4% |
| 4 | Are you given E-modules to study biology material during offline learning?? | 100% | 0% |
| 5 | If you have been given the e-module, can the e-module help you understand the biology material more easily?? | 72,3% | 27,7% |
| 6 | Do you agree if teaching materials are developed in the form of E-modules so that you can learn independently?? | 94,2% | 5,8% |
| 7 | Do you want the characteristics of an E-module that are interesting and easy to understand?? | 97,2% | 2,8% |

Based on the results from the student needs analysis table, it is evident that while students do have textbooks from publishers for their learning process, these textbooks are not designed in an engaging or systematic way to facilitate biology learning. Students find it challenging to study biology, particularly abstract material. Additionally, the textbooks are not designed to develop critical thinking skills. Students also expressed a desire for e-modules with engaging and systematic characteristics to help them better understand biology and enable more independent learning.

3.3. Critical Thinking Skills

The preliminary study of critical thinking skills among 11th-grade students at SMAN 1 Dagangan, as shown in Figure 1, reveals that only two aspects meet the "satisfactory" criteria. These are providing explanations, with a score of 52%, and organizing strategies and tactics, with a score of 56%. The remaining three aspects fall short of the satisfactory level: drawing conclusions at 43%, providing further explanations at 32%, and building basic skills at 20%.



Gambar 1. Percentage of Students' Critical Thinking Skills

Gambar 1. According to Figure 1, all five critical thinking indicators are still in the low category. The low level of students' critical thinking skills is due to the fact that the teaching materials used by teachers are not designed to be engaging and interactive, and students are not actively involved in the learning process. For instance, students are not engaged in project-based activities that would allow them to construct their own knowledge from personal experiences, as suggested by constructivist theory (Sugrah, 2019). Chiu (2020) notes that project-based learning (PjBL) is a group-based approach where students are confronted with real-world problems and practices. PjBL is an educational methodology that can enhance communication skills and critical thinking abilities (Cortázar et al., 2021). The STEM-integrated Project-Based Learning model offers authentic and contextual learning experiences, allowing students to build concepts in science, technology, engineering, and mathematics (Wan et al., 2022). The PjBL-STEM model engages students actively with real-world challenges to achieve a deeper understanding (Agustin et al., 2023). PjBL-STEM-based e-modules are designed with PjBL-STEM syntax to empower students' critical thinking skills.

4. SIMPULAN

Based on the research and analysis, it is evident that both teachers and students need the development of teaching materials in the form of PjBL-STEM-based e-modules to enhance critical thinking skills. This study serves as a preliminary investigation to determine the necessity of developing such e-modules. The results indicate that there is a need for PjBL-STEM-based e-modules to empower critical thinking skills. Therefore, it is recommended that this research be advanced to the development stage..

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