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Preliminary study: Needs analysis of PjBL-based e-modules based on students' critical and creative thinking profiles on the human reproductive system

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ABSTRACT

This study aims to conduct a needs analysis in the development of electronic modules based on *project-based learning* with a focus on Human Reproductive System concepts. The research method used in descriptive qualitative research involving interviews, observations, written tests and questionnaires as data collection instruments. Teaching materials developed in the form of interactive *e-modules* that can contain text, images, and learning videos, as an independent learning effort that is systematically arranged. The results of the needs analysis of 108 students in class XI IPA obtained 91% of handbooks used by students are not sufficient learning resources. According to 94% of students have difficulty understanding Human Reproductive System material, 91% of students need other learning resources that can be understood independently. The results analysis of the critical thinking skills test profile obtained an average score of 39,8% in the low category and creative thinking obtained an average score of 39,1 in the low category of 108 students in grade XI Science Classroom. These results indicate the need to develop teaching materials in the form of interactive *e-modules* of Human Reproductive System based on *project-based learning* to improve critical thinking skills and creative thinking skills.

INTRODUCTION

Education in the 21st century is required to empower higher-order thinking skills and look at problem from various perspectives to solve problems more effectively (Anwar et al., 2020). The challenges of the 21st century demand a learning process that equips students with various skills, such as creative thinking skills, critical thinking and problem solving, communication, and collaboration (Rahayu et al., 2022; Thornhill-miller et al., 2025). This 21st century education is one of the important things to ensure that students have learning and innovation skills (Fajri et al., 2021). Education is also important in shaping students' personalities so that they can face the challenges of the times that will continue to change and develop (Janti et al., 2025; Hesti et al., 2025; Syaban et al., 2024).

The demands of 21st-century education and the implementation of the Merdeka Curriculum are important foundations in supporting the implementation of more effective and relevant education in Indonesia. One of the main competencies that need to be trained is critical thinking which refers to an active thought process to gain deep understanding (Pramudita & Rahayu, 2024). Therefore, educators are needed who have the competence as facilitators when guiding and assisting students in understanding learning materials. One of the efforts to develop critical thinking skills is by developing interesting learning resources and adjusting technological developments, such as interactive *e-modules* (Safrilia & Satrio, 2025). On the other hand, creative thinking skills are an ability to be able to provide solutions and solve problems to that they can create something new. This creative thinking skill is also stated as a skill that aims to be able to solve a problem from various points of view (Fitriyah & Ramadani, 2021).

Critical thinking involves learning perspectives related to science and technology issues in everyday life, and evaluating these perspectives to find solutions or problem solving. Critical thinking also helps students in studying a problem systematically, dealing with different problems, formulating, innovating and designing appropriate solutions to the problems they face (Aini et al., 2020). On the other hand, creative thinking is a person's ability to analyse new information and a combination of unique opinions or ideas to solve a problem. When someone has high creativity, it shows that someone can think creatively. On form of cognitive thinking is creative thinking (Qomariyah & Subekti, 2021). PjBL integration is effective in improving students' critical thinking skills (Astriani et al., 2023).

The development of information and communication technology (ICT) in the 21st century also has an impact on the innovation of teaching materials. *E-modules* are an innovation in the development of teaching materials (Ramadhanti et al., 2023). *E-modules* are systematically designed as teaching materials in the learning process and can be used as an additional source of information for students to find appropriate material concepts. *E-modules* are made in an electronic format consisting of images, videos, quizzes, and other elements, so that the learning process becomes more interactive (Yanindah & Ratu, 2021). The advantages of using *e-modules* are that they are easy to access and carry everywhere, students can study the material again as needed because *e-modules* can be studied independently (Romayanti et al., 2020).

The learning model that will be used when creating teaching materials in improving critical thinking and creative thinking skills is *Project-Based Learning* (PjBL). The PjBL model requires students to complete a project, which involves them in preparation, planning, in-depth research, and development of concepts that can be used to produce projects or products based on the topic being discussed (Mona et al., 2023). Educators must understand the right materials, teaching materials, and learning models to support learning. Previous studies have shown that the PjBL model can effectively influence students' creative abilities in learning Biology (Almulla, 2020; Azzahra et al., 2023; Maesaroh et al., 2024).

Based on the results of observations and interviews with biology teachers and grade XI students at one of the high schools in Karawang City, it shows that students handbooks in learning Biology still use textbook and students' worksheets when learning Biology. In addition, students

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find it difficult to solve problems related to critical and creative thinking skills in understanding biology learning, especially on material about the Human Reproductive System. In addition, the handbook used during the biology learning process does not help them understand the material. Therefore, interactive *e-module* teaching materials are needed as an alternative learning resource in grade XI.

To improve students creative and critical thinking skills, it is necessary to develop teaching materials in the form of interactive *e-modules* based on *project-based learning*. It is expected that the results of this study will provide initial information about teaching materials and learning models that need to be developed for students at one of the high schools in Karawang City. This study aims to analyse the needs of teaching materials in learning Biology, problems that arise during the learning process, and learning resource used by teachers and students. Furthermore, the results of this study are used to develop teaching materials in further research.

METHODS

This study used a descriptive quantitative method. The initial stage was conducted through observation and literature review of theories and previous research results relevant to the development of interactive e-modules in biology learning. The research subjects included 108 students from classes XI-1, XI-2, and XI-3 and two biology teachers at one of the high schools in Karawang City. The data collection instruments consisted of teacher needs analysis interview sheet, a student needs analysis questionnaire, and a critical and creative thinking skills test on the material of the human reproductive system. The teacher interview sheet was used to obtain preliminary information about learning conditions and media needs. This instrument covered three dimensions, namely (1) the suitability of the material with the curriculum, (2) the learning media used, and (3) the need for interactive media. The student questionnaire is used to identify needs and preferences for biology learning media, with three dimensions: (1) interest in biology learning media, (2) learning difficulties experienced, and (3) the need for interactive features in *e-modules*.

The critical thinking skills instrument was developed based on Facione's indicators (2015), which includes six dimensions: interpretation, analysis, inference, evaluation, explanation, and self-regulation. The instrument takes the form of an open-ended test consisting of six questions that require students to provide logical arguments, interpret data, and draw scientific conclusions in the context of biology. And example of a questions is: "*What information can you find in the graph to explain the differences between HIV and AIDS and their relationship in causing disorders in the Human Reproductive System?*". Assesment is based on conceptual accuracy, strength of argument, and scientific reasoning ability.

The creative thinking skills instrument is based on Torrance's indicators (1974), which include four dimensions: fluency, flexibility, originality, and elaboration. This instrument takes the form of an open-ended test consisting of five questions that encourage students to generate new, flexible, and original ideas about biological problems. An example of a question is: "Select one human reproductive organ and explain how a disorder in that organ can affect the entire reproductive system, as well as propose alternative solutions to address the disorder." Assessment is based on the number of ideas, the uniqueness of the answers, and the depth of elaboration displayed by students.

The questionnaire data was analysed descriptively and quantitatively by calculating the frequency distribution and percentage of each Yes and No response. The results of the analysis were presented in a Likert Scale (Checklist) to illustrate the trends and needs of students and teachers regarding the development of interactive *e-modules.*

$$\text{Percentage Result} = \frac{\text{Number of students who answered x } 100\%}{\text{Total of all students}}$$

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RESULTS AND DISCUSSION

Based on the needs analysis during the observation in the interview, the data obtained are listed in Table 1. Data from the questionnaire distributed to students related to the obstacles and teaching materials needed in the picture.

Table 2. Teacher Needs Analysis During Observation

No	Question	Analysis Statement
1	Has the school implemented the Merdeka Curriculum? If so, in which grade did the implementation begin ?	The school has used the Merdeka Curriculum, starting from grades X, XI, and XII which have used the curriculum.
2	What learning model is often applied in the classroom of grade XI ?	The learning model is still conventional with the lecture method, because it is still difficult to condition the class if given a strange learning model.
3	What problems are faced in learning biology ?	Students feel bored during learning because the teacher still uses teaching materials in the form of textbooks and students' worksheets.
4	What is needed of maximized to overcome these problems ?	Need to develop teaching materials that are appropriate in the current era.
5	What teaching materials are commonly used in the learning process ?	The school uses teaching materials in the form of textbooks and worksheets, which not all students have.
6	Do the teaching materials you use support the learning process ?	Already but not maximized.
7	Have students' critical thinking and creative thinking skills shown good results ?	Not yet showing good results.
8	Is it necessary to develop teaching material to support learning activities ?	Very necessary, so that students are not bored in teaching and so that students understand more about the material being taught.
9	Have you ever used *project-based e-modules* in learning ?	Never, because I am not updated regarding technology.
10	What do you think about teaching materials in the form of *project-based e-modules* ?	According to the teacher, *e-modules* can be a good alternative choice. Because in terms of visuals it is more interesting than printed books and so on.

Condition of Teaching Materials in Schools

Based on observations and interviews with teachers, it is known that printed books or student worksheets cannot fulfil the information needs needed for the implementation on the learning process. The situation makes it difficult for students to access the latest information which is very important to keep up with developments in science and technology. In an age where the information age is developing so fast, the need for up-to date learning resources is very important. Therefore, the limitation of printed books is a serious obstacle in supporting an effective learning process. Both students and teachers rely on textbooks as a source of information that helps them understand the subject matter better.

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The Need for Alternative Teaching Materials

Most respondents expressed the need for alternative learning resources. They argue that the materials delivered face to face are not good enough and do not keep up with technological developments. The learning process becomes less effective due to this limitation, especially when the internet becomes the most important part of their daily lives. In addition, respondents emphasized that students do not only have access to the latest information in current teaching materials, causing them difficulties in understanding the latest advances in their field of study.

Electronic Teaching Materials based on Project-Based Learning (PjBL)

PjBL plays in important role in the development of various electronic innovations that are able to solve difficult problems and produce real product from various fields. *Project-based e-modules* are essential in modern learning because they can combine technology with learning approaches that emphasize students' active involvement in completing real projects. Students not only acquire knowledge, but also develop 21st century skills such as critical thinking, creativity, communicative and collaboration.

Based on the results of the distribution of research questionnaires to 108 students in classes XI-1, XI-2, XI-3. The detailed results are interpreted in the following Figures.

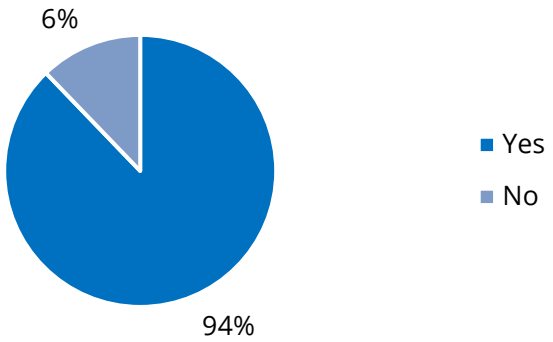

Figure 1. Difficulties in learning biology material on the human reproductive system related to critical thinking and creative thinking.

Based on Figure 1, it can be revealed that as many as 101 students (94%) feel difficulties in learning biology, especially the material of the human reproductive system related to critical thinking skills and creative thinking skills, and as many as 6 students (6%) do not feel difficulties in learning biology of the human reproductive system material related to critical thinking skills and creative thinking skills.

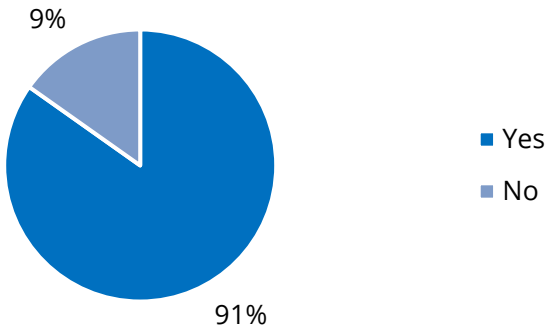

Figure 2. The handbook used is not sufficient as a learning resource

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Based on Figure 2, it can be revealed that 98 tudents (91%) feel that the handbook used is not sufficient as a learning resource. While as many as 10 students (9%) already feel enough to use the handbook as a learning resource.

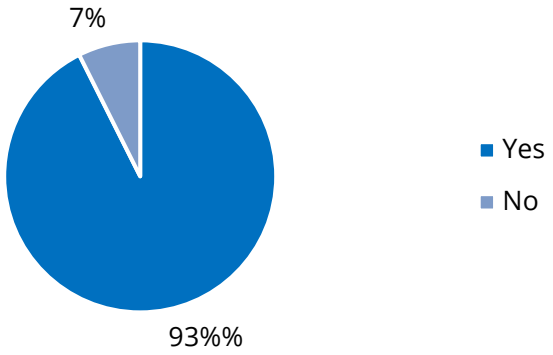

Figure 3. Project method is suitable for human reproductive system material

Based on Figure 3, it shows that 100 students (93%) said that human reproductive system material is suitable for project learning method.

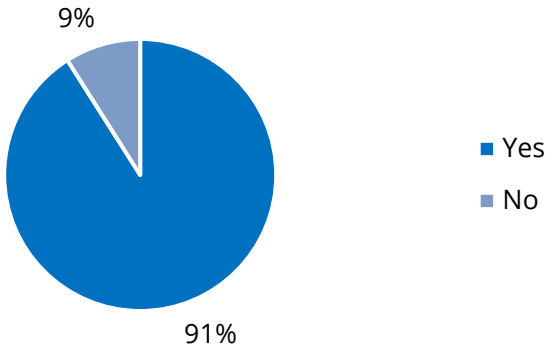

Figure 4. students need other learning resources

Based on Figure 4, it shows that 98 students (91%) need other learning resources to support learning activities.

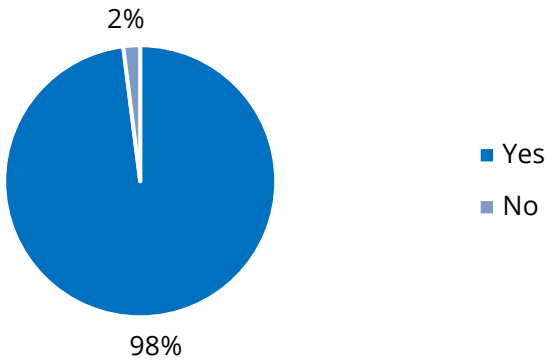

Figure 5. students have never used teaching materials in the form of project based electronic models

Based on Figure 5, it shows that 106 students (98%) have never used teaching materials in the form of project based electronic modules.

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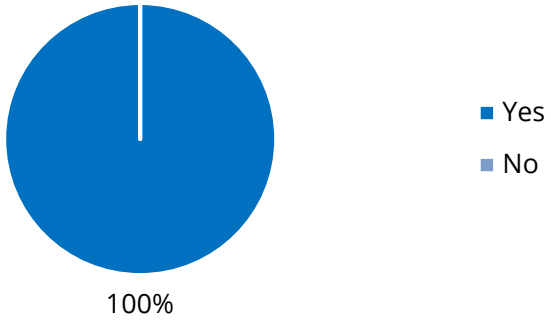

Figure 6. Use of a smartphone or laptop to access the internet

E-module teaching materials require the internet to be accessed. A total of 108 students 100% use smartphones or laptops in accessing the internet.

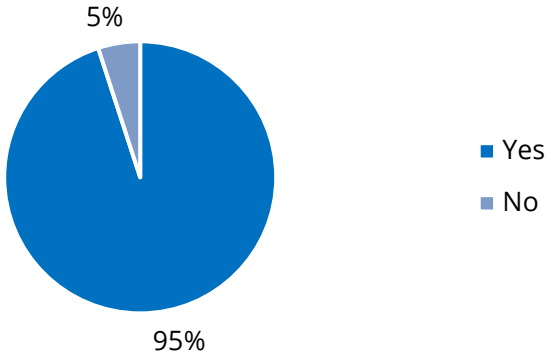

Figure 7. Students are interested in learning biology with *e-modules*

Based on Figure 7, 103 students (95%) are interested in learning biology with teaching materials in the form of *e-modules.*

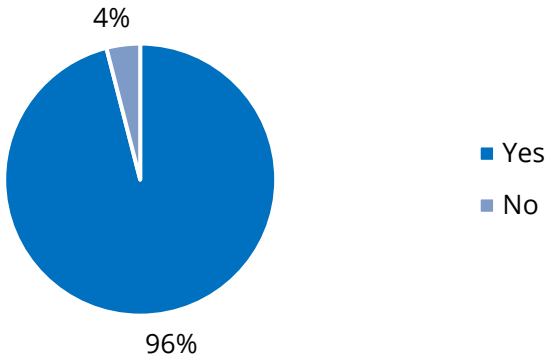

Figure 8. Students want to know and try to learn project-based *e-modules.*

Based on Figure 8, it shows that 104 students (96%) want to know and try to learn using project-based interactive *e-modules* for the biology learning process.

From the results of the student needs questionnaire in the figure, the are several important results related to the current conditions of the learning process, learning media, learning resources, and learning methods, 96 respondents (89%) of students experience difficulties in learning biology, especially in reproductive system material where students are trained to develop creative thinking skills and critical thinking. Most 91% of the handbooks used have not met the needs of learning resources, while 9% feel it is sufficient with the use of other teaching materials

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such as student worksheets and package books. On the other hand, as many as 100 students (93%) revealed that project based methods are appropriate to be applied in human reproductive system material. Furthermore, 91% of students felt the need for additional learning resources to support the learning process activities, citing difficulties in conveying thier understanding. Most of the 98% reported that students had never utilized teaching materials in the form of project based electronic *modules* duirng the learning process. This is due to the lack of training for teachers innovative teaching materials in schools. Interestingly, 95% of grade XI students stated that they have an interest in learning biology by using interactive *e-modules* in studying the human reproductive system. In lne with this, 96% indicated a desire to try learning methods through interactive *e-modules*, reflecting a strong desire for them to have a more interactive and meaningful student learning experience.

Critcal Thinking and Creative Thinking Skills Profile Results

Data obtained based on the percentage results of observations of critical thinking skills tests and creative thinking skills by conencting materials related to understanding diseases and disorders of the human reproductive system. Based on the results of the critical thinking and creative thinking skills profile of 108 students from classes XI-1, XI-2, XI-3. The results are detailed in the following table.

Table 2. Percentage of Critical Thinking Skills Profile Results

Student Critical Thinking Skills Score and Categories	Percentage
81 – 100 (Excellent)	-
61 – 80 (Good)	25.92 %
41 – 60 (Fair)	36.2 %
≤ 40 needs improvement (Low)	37.96 %
Average score	39.8 %

Table 3. Percentage of Creative Thinking Skills Profile Results

Student Critical Thinking Skills Score and Categories	Percentage
81 – 100 (Excellent)	-
61 – 80 (Good)	27.07 %
41 – 60 (Fair)	38.89 %
≤ 40 needs improvement (Low)	37.03 %
Average score	39.1 %

Based on the results of data analysis in Table 2 and Table 3 show that the profile of critical thinking skills of grade XI students was 37.96% in the low category and 36.2% in the moderate category. While in the creative thinking skills of grade XI students amounted to 37.03% low category and sufficient category of 38.89%. based on the average score of the critical thinking skills test, it shows 39.8% and creative thinking 39.1%. from the scores obtained, students are in the low category. These findings indicate that grade XI students need to receive appropriate improvements in order to systematically improve critical thinking skills on human reproductive system material.

Learning the human reproductive system is one of the materials that requires conceptual understanding and higher level thinking skills from students because it is not only biological and scientific, but also includes complex ethical, social and reproductive health aspects (Abdul et al., 2024). Toni et al. (2024) said, learning the human reproductive system requires students to be able to analyze processes related to human reproduction, identify reproductive health problems, and create solutions based on scientific understanding and social empathy.

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Yuliana et al. (2023) highlighted that biology learning is one of the disciplines that really needs teaching materials such as *e-modules*. Biology learning involves legal facts and principles generated through scientific processes, and requires critical thinking skills and creates creative thinking skills. The *e-module* format makes biology concepts more interactive, encouraging students to participate more actively in improving critical thinking skills and creative thinking skills in students (Fahru et al., 2024; Hamidah et al., 2024; Syahfitri & Safitri, 2024).

From the exposure of these results, solutions that can be done to overcome these problems by using learning models that are in accordance with the conditions to improve student understanding (Mutanga, 2024). PjBL is one of the learning models where there are various life problems faced by students (Anwar et al., 2024). *Project based learning* is also known as *project based learning* which is a form of student centered learning charaterized by collaboration, creative, critical, communication and reflection in real world pratice (Rehman et al., 2023; Thapaliya et al., 2024). (1) The *project based learning* model is suitable to be combined with *e-modules* because it allows students to actively participate in the learning process, (2) *project based learning* involves students in problems and ends in real product, (3) *project based learning* has tremendous potential to create interesting and meaningful learning experiences for students (Susanti et al., 2020).

Based on the needs analysis conducted, the problems in learning biology at one of the high schools in Karawang City shows the importance of developing teaching materials in the form of interactive e-modules. Through the development of PjBL based *e-modules*, students are expected to be more independent and will gain a better understanding of biology material, especially human reproductive system material in improving students critical thinking skills and creative thinking skills.

CONCLUSION

The conclusion obtained is that students need a learning resource to be able to strengthen understanding and train critical and creative thinking skills towards learning biologi, especially the material of the human reproductive system and need learning resources that can be understood independently. Based on this, interactive *e-modules* are the right solution to use in learning. The results of this study re recomended to be used as a strong basis for developing PjBL based interactive *e-modules* on human reproductive system material in improving students critical thinking skills and creative thinking skills.

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