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Development of E-Module Based on Socio-Scientific Issues Human Reproductive System Material to Improve Critical Thinking Ability in High School Students

Garlinda Ahwa Aulia Pratiwi, Endah Peniati[1]✉

[1]Biology Departmenti, FMIPA, Universitas Negeri Semarang, Indonesia

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Abstract

This study aims to describe the characteristics, analyze the feasibility, and analyze the improvement of students critical thinking ability using e-module based on socio-scientific issues human reproductive system in learning. This research was carried out at SMA Negeri 1 Demak in the even semester of the 2021/2022 academic year. The type of research is research and development (RnD) using a pre-experimental one group pretest-posttest design. The subjects of this study were XI MIPA 9 to obtain data on student responses to the e-module, and XI MIPA 6 to obtain data on critical thinking ability using pretest-posttest description questions. Sampling using purposive sampling method. The results showed that the characteristics contained in the e-module based on the experts assessement were based on socio-scientific issues, self-instruction, self-contained, adaptive, user friendly, and attractive appearance. The feasibility of material experts is 98.9% with very feasible criteria, media experts is 97.8% with very feasible criteria. The student response to the e-module is 90.9% with very good criteria, the teacher's response is 95.4% with very good criteria. The average of the pretest-posttest of students critical thinking ability was analyzed by n-gain and obtained a score of 0.62 with medium criteria. The conclusion of this research is the development of e-module based on socio-scientific issues human reproductive system material is feasible and effective to improve critical thinking ability of class XI students in SMA Negeri 1 Demak.

✉ Correspondence Address:
D6 Building 1st Floor Jl Raya Sekaran Gunungpati Semarang
E-mail: endahpeniati@mail.unnes.ac.id

INTRODUCTION

In education, the 2013 curiculum is an effort to answer the challenges of the 21st century which is implemented as a strengthening of charater education in schools. One of the 21st century skills that is the target of implementing in learning in the 2013 curiculum is critical thinking. Critical thinking is thinking rationally, responding to a thought that get in the brain to be analyze and evaluated systematically. Activities that can be done to hone these ability are by reading and discuccing. However, the reality says that the level of reading literacy in Indonesia still relatively low. The survey conducted by PISA (Programme for International Student Assessment) in 2018 explained that the reading literacy score of Indonesian children was 371 points, while the average score in OECD (Organisation for Economics Co-operation and Develoment) countries was 487 points (OECD, 2019).

One of the biological materials that can foster critical thinking ability is human reproductive system (Fihani *et al*., 2021). In Permendikbud No. 37 of 2018 concerning KI-KD SMA/MA, the material for the human reproductive system is in KD 3.12 analyzing the relationship of the structure of the reproductive organs making up the network with its function in the human reproductive system and KD 4.12 presenting the results of an analysis of the impact of promiscuity, disease and abnormalities on structure and function organs that cause disruption of the human reproductive system and reproductive system technology.

From the results of interviews with biology teachers at SMA Negeri 1 Demak, the problems found in studying human reproductive system material were that students lack of understanding in gametogenesis and the hormones that play a role in the human reproductive system. Permatasari *et al*. (2017) in her research stated that the obstacles faced in learning biology were the lack of students understanding of content, context, and critical thinking ability because there were too many subjects to be studied. The results of the biology teacher interviews and student needs questionnaires explained that the overall teaching materials used by class XI students were textbooks that had been provided by the school. The dominance of the use of textbooks which are very complex, less directed to the potential and abilities that students can explore, and little discussion of social-scientific issues that are closely related to everyday life make it difficult for students to understand the material and hone their critical thinking ability. Students said that biology learning for the reproductive system was fun and easy to understand. This is inversely proportional to student learning outcomes that there are still many students who get learning outcomes below the minimum completeness criteria (KKM) of the school, which is 70.

According to the biology teacher of class XI, students critical thinking ability was variety, from low to high. Classes with low critical thinking ability are due to less active student involvement in class. In addition, understanding of material concepts is also lower when compared to classes with high critical thinking ability. Therefore, it is necessary to innovate learning that is able to improve student development in scientific thinking and critical thinking, develop moral and ethical reasoning, communicate, social attitudes, and concern for students to solve problems, namely using socio-scientific issues.

The use of socio-scientific issues into the human reproductive system e-module will involve students active roles in discussion activities and analyzing dilemmatic social issues to construct students understanding independently. The importance of involving students active roles in discussions will build communication to develop students ability to process information and argue. These activities not only make biology as a science, but also involve the values of social awareness (Subiantoro, 2017).

Socio-scientific issues can be used because they are relevant to science, attracting students attention (Sadler *et al*., 2016), and relevant to student life (Zeidler *et al*., 2019 dan Sadler *et al*., 2017). However, the use of socio-scientific issues in teaching materials and subject matter is still difficult to find and unfamiliar in Indonesia (Nazilah *et al*., 2018 dan Genisa *et al*., 2020). An Efforts to suppress and facilitate these problems are by making teaching materials that can help students learn independently, contextual in nature, able to make learning student-centered, linking to technology, and contain critical thinking ability, namely e-module.

The selection of teaching materials using e-module is a solution to the limited number of teaching materials in the field that do not utilize the strategy of socio-scientific issues and the use of technology. E-

module become teaching materials that can be used in offline and online learning by taking into the principles of digital learning. The developed e-module is presented online in order to provide easy access for its users because it is not limited by space and time.

The e-module is designed based on the characteristics of the e-module. The cover and content design uses images and colors that are in harmony with the material, so that it gives an interesting and not boring impression. E-module are also designed based on the characteristics of socio-scientific issues that aim to improve students critical thinking ability in achieving the material for the human reproductive system KD 3.12 and 4.12.

RESEARCH METHOD

This research was conducted at SMA Negeri 1 Demak in the even semester of the 2021/2022 academic year. This type of research is research and development (RnD) which modifies Sugiyono's design, including 1) potential and problems, 2) data collection, 3) product design, 4) design feasibility assessment, 5) design revision, 6) product trial, 7) product revision, and 8) use trial.

The first step of this research is to analyze the needs of students and teachers in schools and collect data that is used as a reference to develop this research. The potentials and problems found are used as a basis for developing e-module based on socio-scientific issues of the human reproductive system material to improve the critical thinking ability of high school students. The next step is to validate the e-module design to material experts and media experts to obtain feasibility data and evaluation of e-module. A small-scale trial was conducted by 16 students of XI MIPA 9 and 1 biology teacher to obtain student and teacher responses to the e-module.

Use trials or large-scale trials were conducted to analyze the improvement of students critical thinking ability after using e-module based on socio-scientific issues human reproductive system material. The subjects of the usage trial were 32 students of XI MIPA 6. The usage trial used one group pretest-posttest. The one group pretest-posttest pattern according to Sugiyono (2019: 130-131) is presented in Figure 1.

O_1 X O_2

Figure 1 One Group Pretest-Posttest Design

Description:

O_1 : pretest score

X : treatment

O_2 : posttest score

The question of the description of critical thinking ability before being used for pretest-posttest in the previous usage trial was tested for validity to students who had obtained the material on the human reproductive system, 15 students of XII MIPA 2. Then the results were analyzed using IBM SPSS Statistics 25 with sig.(2-tailed).) 0.05 for validity and Cronbach's alpha 0.6 for reliability.

E-module can be used for offline and online learning using the Student Centered Learning (SCL) method and paying attention to the principles of digital learning. The characteristics of the e-module were analyzed by describing the feasibility assessment by experts. The feasibility of the e-module and user responses (students and teachers) were analyzed descriptively quantitatively. Critical thinking ability were obtained from the pretest and posttest scores. The pretest and posttest scores furthermore analyzed with n-gain to determine the improvement of students critical thinking ability on human reproductive system material.

RESULT AND DISCUSSION

The results obtained in this study was e-module based on socio-scientific issues human reproductive

system material to improve the critical thinking ability in high school students which can be accessed online through the digital publishing platform called issuu.com. E-module can be said to be feasible if the results of the assessment by material experts, media experts, student responses, and teacher responses meet predetermined criteria. The effectiveness of the e-module based on socio-scientific issues human reproductive system material in terms of increasing students critical thinking ability after do on the pretest and posttest questions which are then analyzed using n-gain.

Characteristics of E-Module

The characteristics of e-module were obtained from the feasibility assessment of material experts and media experts. The developed e-module contains characteristics based on socio-scientific issues. E-module based on socio-scientific issues was e-module that contain cases that relate material on the human reproductive system to social-scientific issues that surround the community. Socio-scientific issues are placed in the column let's discuss, practice questions and evaluation questions that can be done by students. The use of socio-scientific issues in learning makes it easier for students to understand the context of the lesson. According to Zeidler & Nichols (2009), socio-scientific issues can improve students reading literacy and critical thinking ability through discussion or debate activities in class. In line with Suastrawan *et al*. (2021), e-module with characteristics of socio-scientific issues are able to improve students critical thinking ability.

Based on the assessments of material experts and media experts, the characteristics of e-module such as self-instruction, self-contained, adaptive, and user-friendly are also fulfilled in the e-module developed by researchers. The display characteristics of the e-module are also well fulfilled. This is assessed from the graphic aspect which explains that in terms of size, color, images, letters, and layout, the feasibility component is very feasible. In line with Andayani (2017), that the use of interesting teaching materials can make it easier for students to understand a material.

Biology learning using e-module based on socio-scientific issues human reproductive system material can be carried out offline or online with a student-centered learning orientation. Online learning cannot be separated from the principles of digital learning. There are six principles of digital learning that must exist in the online learning process, namely the principles of freedom, independence, flexibility, conformity, mobility, and efficiency (Munir, 2017).

Feasibility of E-Module

The feasibility of e-module was analyzed based on the results of the assessment by material experts and media experts. The percentage analysis of the results of the e-module feasibility assessment from material experts obtained an average of 98.9% with very feasible criteria. The percentage of analysis of the results of the feasibility of e-module by media experts obtained an average of 97.8% with very feasible criteria. The analysis of the results of the e-module feasibility by material experts and media experts is presented in Tables 1 and 2.

Table 1 Analysis of E-Module Feasibility Results by Material Experts

Material Feasibility Aspect	Percentage (%)	Criteria
Content feasibility	98,6%	Very Feasible
Serving feasibility	100%	Very Feasible
Language feasibility	98,2%	Very Feasible
Average	**98,9%**	**Very Feasible**

Table 2 Analysis of E-Module Feasibility Results by Media Experts

Media Feasibility Aspect	Percentage (%)	Criteria
Size of e-module	100%	Very Feasible
E-module cover design	95,5%	Very Feasible
E-module content design	97,9%	Very Feasible
Average	**97,8%**	**Very Feasible**

Feasibility assessments from material experts and media experts received suggestions for perfecting e-module based on socio-scientific issues human reproductive system material. Suggestions from material experts are to add pictures to some objective questions. Then media experts suggest to make a good proportion of comparison between text and images on several pages in the e-module.

Assessment of the feasibility of e-module is also based on student and teacher responses to e-module. The results of the assessment of student responses to the e-module obtained a percentage of 90.9% with very good criteria. The results of the assessment of the teacher's response to the e-module obtained a percentage of 95.4% with very good criteria. Analysis of student and teacher responses to e-module is presented in Tables 3 and 4.

Table 3 Analysis of Student Response Results to E-Module

No	Assessment Aspect	Percentage (%)
1	Students feel that the selection of colors and images in the e-module is contrasting and in accordance with the material	96,0
2	Students easily understand the instructions and objectives of this socio-scientific issues-based e-module learning	97,3
3	Students feel that the material, exercises, and evaluation questions presented are in accordance with the title/topic being discussed	96,0
4	Students feel that the problems presented in the e-module are integrated with socio-scientific issues and critical thinking ability	85,3
5	Students feel that the writing in the e-module uses an easy-to-read font	94,7
6	Students feel that the sentences used in the e-module are easy to understand	94,7
7	Students easily understand the material, practice questions, and evaluation questions presented in e-module based on socio-scientific issues	92,0
8	Students feel that the material, practice questions, and evaluation questions presented are related to issues/problems in everyday life	89,3
9	Students are interested in having discussions when they see the presentation of e-module based on socio-scientific issues	80,0
10	Students are encouraged to think critically after reading and understanding e-module based on socio-scientific issues	84,0
	Average	**90,9**
	Criteria	**Very Good**

Table 4 Analysis of Teacher Response Results to E-Module

Assessment Aspect	Percentage (%)	Criteria
Media	100%	Very Good
Contents	85,7%	Very Good
Presentation	100%	Very Good
Language	96%	Very Good
Average	**95,4%**	**Very Good**

The developed of e-module can help students understand the material on the human reproductive system because it uses socio-scientific issues and is structured in easy-to-understand sentences. E-module encourage students to carry out discussion activities. There are practice questions and evaluation questions related to scientific social issues that can be found in the community, so that students are able to reconstruct the concepts found through critical thinking processes and solve problems. In line with Nazilah *et al*. (2018), that the acquisition of student responses to the e-module is in very good criteria. The assessment of the teacher's response to the e-module is to enlarge the image and font size that is the description of an image and the consistency of using the term "secondary oocyte" in the discussion of oogenesis and the menstrual cycle as an ovulated product, not as an "ovum".

The results of the feasibility assessment by experts (material experts and media experts) and user responses (students and teachers) show that the development of the e-module socio-scientific issues human

reproductive system material is very good, so it is feasible to use. This is supported by research conducted by Sofiana & Wibowo (2019); Kamaruddin *et al*. (2021); Setiadi & Putra (2021); dan Dalaila *et al*. (2022), that teaching materials based on socio-scientific issues are feasible to use.

Critical Thinking Ability

Learning treatment using e-module based on socio-scientific issues human reproductive system material aims to train students critical thinking ability. Students critical thinking ability was measured by pretest-posttest using a description of 8 questions. The pretest and posttest scores were analyzed using Microsoft Excel 2019. The results of the pretest-posttest scores are presented in Figure 2.

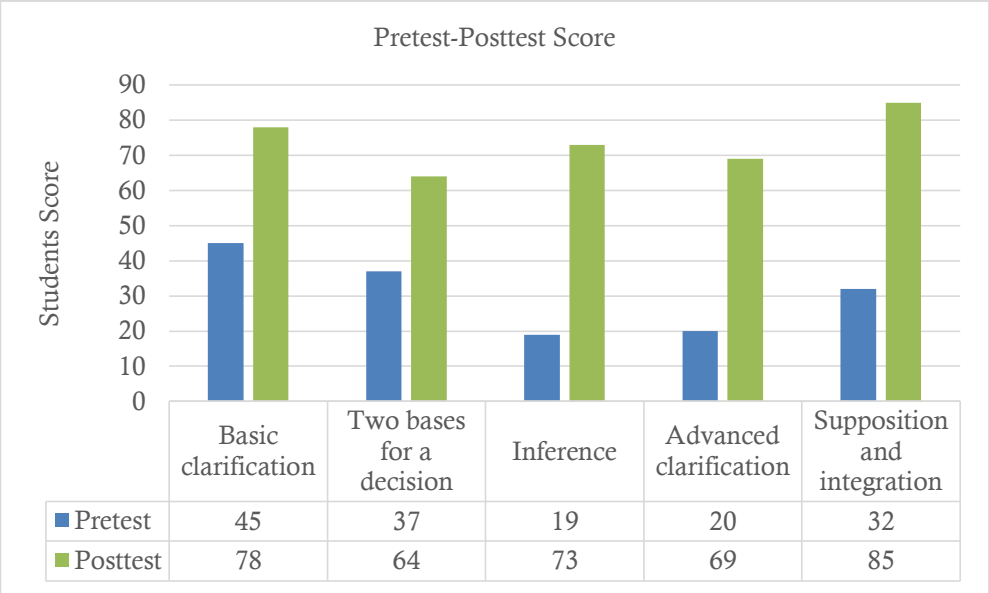

Figure 2 Students Pretest and Posttest Scores on the Aspect of Critical Thinking Ability

From Figure 2 shows that the average acquisition of posttest scores is higher than the average acquisition of pretest scores. The average pretest score in each aspect of critical thinking ability is not more than 50, while the average posttest score exceeds 50 to reach 85. The lowest pretest score is in the inference aspect with a value of 19, while the highest pretest score is in the basic clarification aspect with a value of 45. The lowest posttest score is in the aspect of two bases for a decision with a value of 64, while the highest posttest value is in the aspect of supposition and integration with a value of 85.

Furthermore, the acquisition of the average value of the pretest and posttest is used to analyze the n-gain score which aims to determine the improvement of students critical thinking ability. The results of the n-gain score analysis on each aspect of critical thinking ability are presented in Table 5.

Table 5 N-Gain Score Analysis on Critical Thinking Ability Aspects

Aspects of Critical Thinking Ability	Question Number	N-gain Score	Criteria
Supposition and integration	6, 8	0,77	High
Basic clarification	1, 2, 3	0,60	Medium
Two bases for a decision	4	0,43	Medium
Inference	5	0,66	Medium
Advanced clarification	7	0,61	Medium
Average		**0,62**	**Medium**

Based on Table 5, the lowest n-gain score is in the aspect of two bases for a decision with a score of 0.43 medium criteria, while the highest n-gain score is in the aspect of supposition and integration with a

score of 0.77 high criteria. The average n-gain score obtained in all aspects of critical thinking ability is 0.62. This shows that the increase in student learning outcomes in the aspect of critical thinking ability is in the medium criteria.

In this study, several things were found that can be discussed for further research. First, in the results of pretest, there were no students who scored zero. These results indicate that all students are ready with their critical thinking ability before learning, even though the material for the human reproductive system has not been taught. Students do not have in-depth knowledge of the material of the human reproductive system but already have the ability to think critically. Both of these things can be made possible because students learn before the teacher gives a material.

Second, the average student pretest results are low. The low pretest results indicate that students critical thinking ability are still in the low category. This is possible because during the learning process, the teacher does not train students critical thinking ability. In line with research Agnafia (2019) which shows that students critical thinking ability are low because students are not trained in critical thinking, so that aspects of critical thinking ability are less honed. The solution offered is that teachers can innovate and create learning designs in the classroom, make teaching materials and evaluations of learning that are able to train students critical thinking ability.

The use of e-module based on socio-scientific issues developed by researchers for learning still cannot achieve an n-gain score in the high category. There are several factors that may underlie this. First, the limited time in implementing e-module based on socio-scientific issues to improve students critical thinking ability. The application of socio-scientific issues in biology learning takes a long time, because students must analyze the relationship between the material and the issues discussed in class (Septiningrum *et al*., 2021). This is supported by Suastrawan *et al*. (2021) who said that critical thinking ability cannot be obtained instantly, but need a long and continuous process.

Second, students do not take advantage of the use of e-module based on socio-scientific issues human reproductive system material. During the implementation of learning, it was found that some students had not yet accessed the e-module before learning. This is supported by Suastrawan *et al*. (2021) which explains that when the teacher asks students to use the e-module, the student does not carry out the order, so that the use and utilization of the e-module is less than optimal.

Third, students do not take advantage of the practice questions presented in the e-module which functions to train students critical thinking ability through solving a problem. Supposedly with the independent teaching supplement, students are more challenged to be able to learn and understand a material more focused and intensively. However, the practice questions in e-module based on socio-scientific issues human reproductive system material are underutilized. Students do not carry out the instructions ordered by the teacher. The possibility that causes this to happen is that the average questions presented in the e-module are essay. Students prefer the form of multiple choice questions compared to essay. In line with that, Kristiana *et al*. (2019) explained that the learning experience will affect the level of students critical thinking ability. The more intensively students are in honing their critical thinking ability, students critical thinking ability will be better.

CONCLUSION

Based on the results of data analysis and discussion, it is concluded that the developed e-module contains characteristics such as based on socio-scientific issues, self-instruction, self-contained, adaptive, user friendly, and attractive appearance. E-module based on socio-scientific issues human reproductive system material are suitable for use in learning biology and have received very good responses. E-module are effective to improve students critical thinking ability at SMA Negeri 1 Demak in medium criteria.

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