

Development of problem-based interactive e-modules to improve students' critical thinking skills and mastery of concepts

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Abstract

Keywords:

Articulate storyline 3;
Critical thinking;
Digestive system; E-
module; Mastery of
concepts

This interactive E-module development research aims to improve students' critical thinking skills and mastery of problem-based concepts on digestive system material. The research method used is R&D (Research and Development) with a qualitative descriptive approach. The software needed to develop this E-module is Articulate Storyline 3. The validation results from the assessment of students obtained the percentage of material in the E-module by 90%, the contribution of problem-based interactive E-module to improve thinking skills and mastery of concepts by 89.92%, and the ease of operation of problem-based interactive E-module by 89.11%. So that the average percentage is 89.67, where the presentation shows a very decent category. Thus, problem-based interactive E-modules to improve students' critical thinking skills and mastery of concepts on digestive system material are worthy of being used as a source of learning for learners.

To cite this article:

Yuliani, Y., Djarot, P., & Retnowati, R. (2024). Development of problem-based interactive e-modules to improve students' critical thinking skills and mastery of concepts, *Thabiea: Journal of Natural Science Teaching*, 7(2), 152-166.

Introduction

Education is the most influential initial foundation in improving the quality of life of a nation. Through the educational process, a person's knowledge will increase. Education can be used as a benchmark for the quality of human resources at this time (Pramana, 2020). In essence, education is one of the basic needs in human life in order to maintain life (Asfar et al., 2020). Improving the quality of education is a concern of every nation, including Indonesia (Wati et al., 2019). The level of education in Indonesia is currently still ranked relatively low compared to other countries (Anisa et al., 2021). This is evidenced by the results of a survey on the secondary education system in the world in 2018 issued by PISA (Programme for International Student Assessment) in 2019, Indonesia occupies a low position of 74th out of 79 other countries in the survey. In other words, Indonesia is in the 6th lowest position (Kurniawati, 2022).

Education is not enough just with the learning process, but a structured system is needed so that education in each school institution can be active and sustainable (Susriani, 2021). The existence of teaching materials will help teachers design learning, while for students teaching materials will help them master learning competencies (Kimianti & Prasetyo, 2019). Teaching materials are not only in the form of books or modules, but can take other forms (Magdalena et

al., 2020). One of these innovations is the presence of electronic or digital module teaching materials or commonly called E-modules (Efendi & Nurzaelani, 2021). E-Module is a form of presentation of independent learning materials that are arranged systematically into certain learning units, which are presented in electronic format, where each learning activity in it is connected with a link (link) as navigation that makes students more interactive with the program, equipped with the presentation of video tutorials, animations and audio to enrich the learning experience (Yayang & Eldarni, 2019).

The challenge of education in welcoming 21st century skills is that with the curriculum currently being developed, namely the independent curriculum, current education must prioritize critical thinking skills that can be developed in students at the high school level. The curriculum at the High School level has been designed in such a way as to prepare high school students who are prospective students who will continue to a higher level (university) so that critical thinking skills must be prepared. This can also be identified from the competencies contained in the 2013 curriculum for Senior High School level starting from level C3 (applying) to C6 (creating). The implementation of the 2013 curriculum at the high school level is actually a philosophy of learning in high school which will later be prepared for taking the next level. Therefore critical thinking skills are needed in learning.

Biology is a science that studies events, symptoms and problems related to living creatures. Based on this, students are directed to interpret and solve problems regarding symptoms related to living things. So that learning objectives can be achieved, problem-based e-modules can be a solution. Problem-based e-module is an e-module that challenges students to think critically in solving existing problems because it presents several problems that use Problem Based Learning syntax. Problem Based Learning (PBL) was first implemented at the medical faculty of McMaster University in Canada in 1970 (Amir, 2009). This learning model is designed to direct students' thinking, problem solving, and intellectual skills. Critical thinking habits in Indonesia are carried out through learning activities with a scientific approach by conducting scientific investigations (Wahyudi et al, 2015).

Critical thinking can be interpreted as a person's effort to check the truth of information using the availability of evidence, logic, and awareness of bias (Sulaiman & Syakarofath, 2018). One of the lessons that requires teaching materials in the form of E-modules is Biology. In the process of teaching Biology, a method is needed that can equip students to achieve the expected competencies in the curriculum. One of the right methods is the practicum method. With practicum activities students are able to master concepts, facts and science processes so as to improve students' skills. Practicum activities in Biology material will arouse students' curiosity and scientific attitudes towards natural phenomena, as well as challenge them to think critically in finding alternative solutions to a problem (Suryaningsih, 2017).

Thus, this interactive E-Module can be used as the best alternative to improve students' critical thinking skills and mastery of concepts. E-module is teaching material packaged digitally. E-modules can help teachers provide facilities for students in learning. E-modules are also digital teaching materials that are arranged systematically so that students can learn independently and solve existing problems in accordance with today's era where everything is digital. Based on this opinion, it can be concluded that E-module is a type of digital teaching material that is systematically arranged and presented in electronic form. (Pramana, 2020) states that interactive E-modules can be used to significantly improve student learning outcomes.

This e-module can be designed using the Articulate Storyline 3 application. Articulate storyline 3 is a learning media maker application supported by text, image, audio, and video content that can be adjusted to learning objectives. The resulting media is also supported by interesting quiz content, so that students can immediately actively interact in learning activities (Husain & Ibrahim, 2021). The results of preliminary research show that the critical thinking skills of YPHB high school students are still low. A total of 50 students who were tested for critical thinking skills, found that the critical thinking skills of YPHB High School students were still in the very poor category, namely around a score of 15.73%, therefore it is necessary to improve students' critical thinking skills so that they can implement one of the learning skills. 21st century. The results of a literature study of 15 international journals regarding teaching materials concluded that interactive teaching materials can improve student learning outcomes significantly. Biology subjects in the current era of digitalization provide research opportunities to develop teaching materials or digital-based learning media in the form of interactive E-Modules.

The use of innovative learning media based on information technology has great potential to improve the quality of learning, because it is an effective and efficient way of conveying information (Hutahaeen et al., 2019). The aim of this research is to produce problem-based interactive E-module teaching materials that can improve students' critical thinking skills and mastery of concepts in the Digestive System material.

Method

The research method in this study is R&D (Research and Development). R&D is a method that can test the effectiveness of developed products (Nurhasnah et al., 2020). One of the teaching material development designs that is often used is the ADDIE model (Cahyadi, 2019). The concept of this ADDIE model applies to build basic performance in learning, namely the concept of developing a learning product design (Hidayat & Nizar, 2021). The use of R&D method in this study is because the final result of this research is a Problem-Based Interactive E-Module product. In development research, one development model is known, namely the ADDIE model. The ADDIE development model is a learning design model that is based on an effective and efficient systems approach and an interactive process, namely the results of the evaluation of each phase can take learning development to the next phase. The final result of one phase is the initial product for the next phase. This model consists of 5 main phases or stages, namely: 1) Analyze, 2) Design, 3) Develop, 4) Implement, and 5) Evaluate. This research uses the R & D method because the final results of this research will produce a problem-based interactive e-module product. Prior to limited trials, E-Module products are first validated by media experts and material experts. This teaching material was tested at YPHB High School on 10 class XII Science students and implemented on 30 class XI students.

The population of this study was students of grade XI Science and XII IPA SMA YPHB Bogor. This teaching material was tested on 10 students of grade XII science and implemented on 30 students of grade XI. Before being tested, this teaching material was validated first by media experts and material experts. The data collection techniques carried out are tests and questionnaires. The test questions are in the form of descriptions consisting of essay questions to measure students' critical thinking skills and to measure mastery of concepts using multiple-choice questions with levels C2 to C5. In this research, limited implementation was carried out

using pre-experimental methods. The research did not allow for control, because there were no comparable teaching materials that could be used by the control class. The teaching materials used in the research are problem-based interactive e-modules, while those available in schools are printed teaching materials from various publishers, so the two cannot be compared as controls. One group pre-test posttest design, there is only an experimental group without a control or comparison group (Fraenkel, et.al, 2005). The experimental group in this study used problem-based interactive e-module teaching materials. The develop stage is explained with the design can be seen in Figure 1.

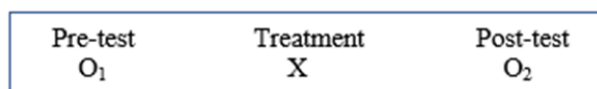


Figure 1. Problem-Based Interactive E-Module Implementation Design

The data obtained in this research is in the form of quantitative and qualitative data. Qualitative data is in the form of suggestions on validation questionnaires and product trial questionnaires to see product effectiveness. Quantitative data is obtained from calculating scores which are then used as indicators as a starting point for compiling or improving teaching materials.

Results and Discussion

The development of a problem-based interactive E-module on digestive system material began with observations at YPHB Bogor High School. The interactive E-module development model used is the ADDIE model. This model involves five stages: analysis, design, development, implementation, and evaluation. The analysis involves five steps: analyzing learning activities, the needs of teaching materials, learning materials, student characteristics, and the curriculum. Based on a preliminary study in the form of a questionnaire to students, most of the learning resources used are still in printed form and still need teacher guidance in their implementation. So, some students and teachers expect an interactive E-module. Some of the questions used in preliminary research can be seen in the following Table 1.

Table 1. Preliminary Test Results for E-Module Requirements

No.	Question	Frequency		Presentation	
		Yes	No	Yes	No
1	Are you enthusiastic about learning Biology in class?	40	20	67%	33%
2	Are you having difficulty studying the Digestive System material, which has very extensive material?	58	2	97%	3%
3	Do you have a textbook or other handbook for digestive system material?	59	1	98%	2%
4	Are you looking for other materials besides the books provided at school to help you understand the	52	8	87%	13%

	material being taught, for example; internet, magazines or other books?				
5	If the presentation in teaching materials is dominated by pictures. Does it help you to understand the organs of the digestive system?	56	4	93%	7%
6	Do you need alternative teaching materials that can be used to make studying the digestive system easier and more interesting?	20	40	33%	67%
7	Do you agree if interesting Biology teaching materials based on Problem Based Learning are developed?	47	13	78%	22%
8	Have the teaching materials used so far guided you to think critically?	47	13	78%	22%
9	Do you feel that your learning outcomes have not been maximized in studying biology to reach the level of analysis?	50	10	83%	17%
10	Has your teacher ever used the module?	52	8	87%	13%
11	Are you interested in modules in electronic form?	52	8	87%	13%
12	Do you think the PBL-based E-Module will increase your ability to think critically?	52	8	87%	13%
13	Do you agree that it is necessary to develop teaching materials such as the Digestive System module based on Problem Based Learning to teach the concept of the digestive system so that the concept is easy to understand?	52	8	87%	13%
14	Do you experience difficulties with the teaching materials and methods that teachers have applied so far?	55	5	92%	8%
15	Do you find the Digestive System material difficult to understand?	48	12	80%	20%
16	Does the availability of libraries and laboratories help you in understanding the digestive system?	54	6	90%	10%
17	Does your teacher teach digestive system material with certain teaching materials (for example modules, teaching aids or videos)?	56	4	93%	7%
18	Has a teacher ever taught you to start learning from a problem?	31	29	52%	48%
19	Do you find it difficult to discuss the problem given?	49	11	82%	18%
20	Will having a PBL-based E-Module improve your critical thinking skills?	50	10	83%	17%

Various technological innovations make the teaching and learning process more efficient, innovative and dynamic (Simarmata et al., 2019). Judging from the concept of the digestive system, material related to everyday life allows students to practice critical thinking skills. Carrying out basic competencies in digestive system material also greatly supports the improvement of students' critical thinking skills.

The design stage is done by making flowcharts and storyboards. Storyboards are made to ease the workflow of the E-module being developed. Creating an E-module framework in

the form of an overview of the material from an interactive E-module, defines the display design of the E-module. Setting the appearance of the E-Module is made so that the resulting display is more attractive and easy for users to use. Develop assessment instruments to determine the validity of the developed E-module. RPP is designed as a reference for implementing E-module in the classroom. The problem-based interactive E-module display flowchart can be seen in Figure 2.

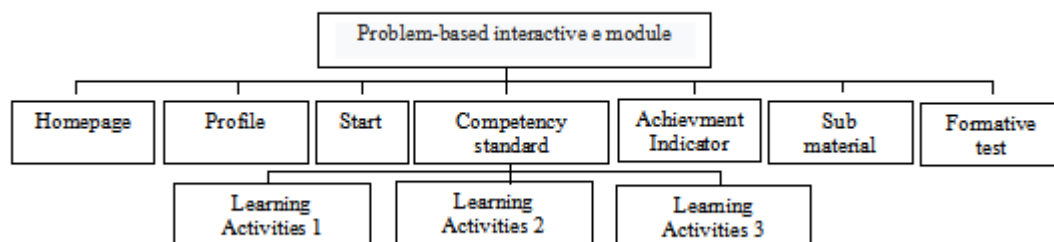


Figure 2. Problem-Based Interactive E-Module Flowchart

This development stage is carried out by adjusting teaching materials about the digestive system, which are sourced from various references. This development stage involves media and material experts to suggest improving the E-Module. Problem-based Interactive E-Module validity test aims to test the feasibility level of the developed E-Module. The instrument used is a questionnaire that a competent expert has previously validated. The validation involved four lecturers: two media expert lecturers and two media expert lecturers. The assessment was carried out using a Likert scale questionnaire with a value of 1 to 4 in testing the validation by the validator team using indicators from several indicators. Validation by media experts includes aspects of screen design display, ease of use, consistency, usability and graphics. The results obtained from 2 media expert validators can be seen in Table 2.

Table 2. Results of E-module Validation by Media Experts

Aspect	Score Percentage		Avg Score Percentage	Category
	Media Expert 1	Media Expert 2		
Display screen design	94.3%	88.6%	91.4%	Excellent
Ease of use	82.9%	85.7%	84.3%	Excellent
Consistency	100%	93.3%	96.7%	Excellent
Benefits	93.3%	86.6%	90%	Excellent
Graphics	100%	91.4%	95.7%	Excellent

The validation from material experts also includes several aspects, namely the content's feasibility, the writing's readability, language, presentation and evaluation. The validation results from material experts can be seen in Table 3.

Table 3. Results of E-Module Validation by Material Experts

Aspect	Score Percentage		Avg Score Percentage	Category
	Material Expert 1	Material Expert 2		
Content eligibility	93.3%	100%	96.7%	Excellent
Text readability	91.4%	94.3%	92.9%	Excellent
language	86.7%	100%	93.3%	Excellent
Presentation	86.7%	96.7%	91.7%	Excellent
Evaluation	90%	100%	95%	Excellent

The E- module's interface and fill in the e module can be seen in the Figure 3 and 4.



Figure 3. E-Module Interface



Figure 4. Fill in The E-Module

Validation from science teachers in the form of a questionnaire was also carried out using a questionnaire consisting of content quality and learning objectives, program aspects, PBL syntax, E-Module components, Ease of operation of E-Modules, and E-Module Potential in learning. The results of the E-Module Validation from science teachers conducted by 20 teachers can be seen in Table 4.

Table 4. Results of E-Module Validation by Science Teachers

Aspect	Avg Score Percentage	Category
Quality of content and learning objectives	94.90%	Excellent

Program	91.20%	Excellent
PBL syntax	96.25%	Excellent
E-Module Components	94.50%	Excellent
Ease of Operation	92.75%	Excellent
E-Module	94.14%	Excellent

The results of problem-based interactive E-Module validation can be seen in Table 4. Based on the results of media expert validation which consists of screen design displays, ease of use, consistency, usability and graphics show an average percentage of 91% and material expert validation of 94.8%, which means that the interactive E-module based on digestive system problems is valid according to the eligibility level qualification of the E-Module. The percentage figures obtained from the validation of material expert lecturers, media experts and science teacher responses indicate that the E-Module developed is in an outstanding category and is suitable for learning can be seen in Table 5.

Table 5. Product Validity Test Results

Validity Type	Results	Qualification
Media Expert Validation	91%	Excellent
Material Expert Validation	94.8%	Excellent
Limited test (10 students)	95%	Excellent
Science teachers (20 people)	94%	Excellent

The revision of the interactive E-Module based on digestive system problems was carried out based on several suggestions from media experts and material experts so that the product is of higher quality. The validator's suggestions and comments on the interactive E-Module based on digestive system problems and follow-up efforts can be seen in Table 6.

Table 6. Validator and Revision Suggestions and Comments

No.	Comments and Suggestions	Revision
1	Media Expert Lecturer 1 <ul style="list-style-type: none"> • Each slide is given a navigation symbol to make it more directional • More interactive videos about everyday things about the digestive system • Added audio writer to make it more interactive • PBL syntax does not need to be displayed 	<ul style="list-style-type: none"> • Added navigation per slide • Videos are taken that are more about everyday events • Added author's audio to make it easier for students and accommodate auditory students • The PBL syntax is found in the learning activities of each sub-chapter

No.	Comments and Suggestions	Revision
2	Media Expert Lecturer 2 <ul style="list-style-type: none"> • Symbols that are not essential in the sub-discussion should be deleted to make it more clear • Add interactive pictures to make them more alive • The font color is contrasted with the base color 	<ul style="list-style-type: none"> • Unimportant symbols are removed • Added interactive images • The font color is contrasted with the base color (template)
3	Material Expert Lecturer 1 <ul style="list-style-type: none"> • The material in interactive E-Modules is linked so that it is more concise and more interactive (use barcodes or video formats) • Bibliography add from the journal 	<ul style="list-style-type: none"> • The material is replaced in the form of a barcode • Bibliography related to material added from journals
4	Material Expert Lecturer 2 <ul style="list-style-type: none"> • There should be only one practice question in the E-Module and it should be broad in scope so that it is represented in every learning activity 	<ul style="list-style-type: none"> • Only 1 practice questions for each Study activity and questions extend to cover the whole
5	Practitioner <ul style="list-style-type: none"> • The video was re-checked because it was running sluggishly • It is advisable for students to use laptops because the display on HP is small • It is recommended to use the E-Module using a strong internet signal 	<ul style="list-style-type: none"> • Re-convert the video to make it lighter • Students are encouraged to use the E-module according to students' needs and convenience • It is recommended for students when learning to use a strong signal when using the E-Module

The interactive E-Module that has been developed meets several criteria for the characteristics of a good E-Module including (1) Self-instruction, in which there are clear learning objectives, materials, communicative language practice questions, assessments that can be carried out by students themselves as well as references or references and a glossary. (2) Self-contained, where the presentation of chapters and sub-chapters is arranged sequentially so that students can learn it in its entirety. (3) Standalone, where the E-Module is complete without using other teaching materials. (4) Adaptive, in which the developed E-Module keeps up with current developments and presents up-to-date news. (5) User-friendly, where the E-Module is very easy for students to use with a navigator, which makes it easier to add audio from the author makes it easier for students to use the E-Module. Learning activities 1, 2 and 3 contain videos that students must observe and then the students and their group friends answer the questions given and present them according to the PBL model syntax. Each learning activity is also equipped with practice questions, additional material which is directly linked to the website, and at the end there is a formative test which can measure the student's level of success in studying the sub-chapter. Formative test questions via the G-Form link. The display of learning activities and Formative Test links can be seen Figure 5.



Figure 5. Display of E- module Learning Activities

The implementation phase is a limited field trial phase to determine the application of an interactive E-Module based on digestive system problems. This trial aims to determine the feasibility of the E-Module being developed. The trial was carried out in class XI with as many as 30 students by providing pretest and posttest questions, and the aim was to determine the effectiveness of the E-Module that had been developed. The reliability test was carried out using SPSS with the Alpha Cronbach alpha formula at 0.78 for critical thinking skills questions in essay form and 0.77 for concept mastery questions in multiple choice form.

Test questions that will be tested on students who will later learn with the E-Module were previously validated, consisting of rational validation carried out by material expert lecturers and empirical validation carried out by testing these questions on class XII students who had received digestive system material. As many as 30 students.

Testing by material experts for critical thinking skills questions as well as mastery of concepts was carried out by two material expert lecturers. The validation results by subject matter expert lecturers from a number 18 critical thinking skills in the form of essays and 22 questions on concept mastery regarding the material of the digestive system, which was validated, turned out to have had several revisions. The revision was carried out after all the questions had been empirically validated through class XII students who incidentally had studied the material on the digestive system in class XI. All data were collected during implementation and processed based on statistics. The processed data is in the form of validation results from a team of media and material experts, limited tests, and E-Modules in class. The implementation results were seen by means of problem-based interactive E-Modules used in class in learning and students working on pretest and posttest questions in the form of 5 questions on critical thinking skills in the form of essay questions and 15 questions on mastery of concepts in the form of multiple choices. From the scores obtained from the pretest and posttest, the N-Gain value is calculated. The N-Gain results of critical thinking skills and mastery of concepts can be seen in Table 7.

Table 7. N-Gain Critical Thinking Skills and Concept Mastery

Type of Question	Average Score		N-Gain	Category
	Pretest	Posttest		
1. Critical Thinking Skills	45.78	90.22	0.82	High
2. Concept Mastery	40.44	88.22	0.77	High

Students' critical thinking skills are classified into five aspects, namely providing simple explanations (elementary clarification), building basic skills (basic support), drawing conclusions (inference), providing further explanations (advance clarification), and working out strategies and tactics (strategies). and tactics). The data was obtained through critical thinking skills question instruments in the form of essay questions which will be given at the beginning of learning (pretest) and the end of learning (posttest). The final result is obtained by calculating the N-Gain value. Students' concept mastery based on cognitive levels C2 to C5. This concept mastery is presented in the form of multiple-choice questions. This concept mastery is also carried out before and after learning. The final result can be seen with the N-Gain value.

Improving students' learning skills by using interactive E-Modules based on digestive system problems can be seen in increased scores from the pretest to the posttest, which has increased. The value of each aspect tested on students also increased, as seen from the N-Gain value of each aspect. The improvement in each aspect of the critical thinking skill essay questions can be seen in Table 8. Based on the N-Gain value category table, the N-Gain value for each aspect is above 0.73, which means it is in the high category. The increase in these five aspects is because students are accustomed to giving simple explanations, building basic skills, concluding, providing further explanations, and developing strategies and tactics for each problem presented in the E-Module, both in the discussion of learning activities and practice questions.

Table 8. N-Gain Students' Critical Thinking Skills for Each Aspect

No.	Aspect Type	Average Score		
		Pretest	Posttest	N-Gain
1	Give a simple explanation	48.89	92.22	0.87
2	Build basic skills	54.44	93.33	0.85
3	Conclude	52.22	88.89	0.73
4	Provide further explanation	36.67	96.67	0.96
5	Develop strategies and tactics	35.56	83.33	0.74

The increase in students' mastery of concepts after using the problem-based interactive E-Module on digestive system material can be seen from the N-Gain scores of the pretest and posttest in Table 9. The average value of the pretest score obtained on the concept mastery test was 40.44, and the average score was 40.44. posttest of 87.11 with an average N-Gain value of 0.77 means it is in the high category. This is because, in learning using problem-based interactive E-Modules on digestive system material, students are also trained in multiple-choice questions with the cognitive domain of Bloom's taxonomy from C2 to C5 on formative tests for each learning activity so that students get used to working on questions from the easiest level to a higher level.

Table 9. N-Gain Improvement of Student Mastery of Each Aspect

No.	Test Type	Average Score		
		Pretest	Posttest	N-Gain
1	Mastery of Concepts (C2 to C5)	40.44	87.11	0.77

Problem-based interactive E-Module learning, whose application uses the syntax of the Problem-Based Learning learning model, also allows students to learn to solve problems by discussing with their group mates, followed by presentations and class discussions regarding all the problems that occur in everyday life until finally concluding also installing strategies and tactics. The problems contained in the e-module include cases of food poisoning, Arya's obesity case and guava which can cause appendicitis. This statement also agrees with the research conducted (Junaidi, 2020), which states that Problem-Based Learning is a way of learning models that can be carried out by teachers to students in facilitating students in increasing their ability to apply concepts to new/real problems, the desire to learning, self-directed learning, as well as developing skills. This is also the same as what was stated (Mahanal Susriyati, 2019 and Mayasari Tantri et al., 2016) which states that the challenge of the world of education today is to prepare young people who have 21st-century skills, one of which is critical thinking skills. This critical skill can be trained with constructivism learning, and a form of constructivism learning that is very appropriate to current conditions is Problem-Based Learning. Habituation of learning can improve students' critical thinking skills as well as mastery of concepts, all of which can facilitate students to be able to achieve the basic competencies listed in the 2013 curriculum, and it is hoped that it can also support students' achievement in solving questions for a higher level. So that it is possible with the application of the Problem-Based Learning syntax contained in the problem-based interactive E-Module, which is manifested in every learning activity, making students accustomed to making simple explanations to further explanations, conclusions also develop tactical strategies which are aspects of critical thinking, and this causes there the increase in scores obtained by students on pretest and posttest scores both on questions of critical thinking skills and mastery of concepts. As expressed by Happy & Widjajanti (2014), Learning must involve students actively and facilitate students to be able to use higher-order thinking skills. Instruction related to critical thinking has become an effort to develop students to become individuals who are quite independent and think critically (Lee et al., 2013). Teachers should be able to design learning that is interactive, inspiring, fun, challenging, and motivates students to actively participate in accordance with Permendiknas No 41 of 2007 concerning Process Standards. Students should be involved in learning activities.

Based on the results of direct observation, when the problem-based interactive E-Module was used, students felt happy and excited to know more about the contents of the E-Module. Moreover, this E-Module can be accessed via a cellphone or laptop. Learning using the E-Module was carried out in class XI IPA 4 with as many as 30 students in three meetings. The first meeting begins with a pretest to determine students' initial abilities. It continues to discuss learning activities 1, the second meeting directly discusses learning activities two and the third meeting discusses learning activities three ending with a post-test. All learning

processes are carried out using the Problem-Based Learning (PBL) model, with the entire PBL syntax integrated into each learning activity in the E-Module. While carrying out the problem-based interactive E-Module trial, two observers were also accompanied, namely the Biology teacher and the Physics teacher as the Deputy Head of the School for Curriculum, to see the implementation of learning in the classroom. Of the 16 aspects observed (as contained in the RPP), all were implemented well, and the two observers assessed the implementation of learning using the PBL syntax model in class. The observation sheet can be seen in the attachment.

The implementation of the problem-based interactive E-Module that was carried out can be said to have shown significant results both in critical thinking skills and mastery of the concept, all of which can occur because students have already carried out learning by applying the teacher with the syntax of the Problem-Based Learning method. According to Hallinger & Lu (2011), Problem-Based Learning is a problem-oriented method. Problems are taken empirically, students are responsible and active in learning, and most of the learning occurs in small groups, and students try to find solutions to these problems. Nafiah & Suyanto (2014) added that in investigative activities, students use critical thinking stages to investigate problems, analyze based on evidence and make decisions based on the results of the investigation.

At this evaluation stage, the authors evaluate the use of problem-based Interactive E-Modules. Researchers take data from student response questionnaires. The results of the student response questionnaire analysis can be seen in Table 10.

Table 10. Results of Student Response Questionnaire Analysis

No.	Aspect	Score	Ideal Score	Percentage	Category
1	Material in E-Module	540	600	90%	Excellent
2	Contribution of problem-based Interactive E-Modules to improve critical thinking skills and mastery of concepts	1079	1200	89.92%	Excellent
3	Problem-based ease of operation of the Interactive E-Module	802	900	89.11%	Excellent

Referring to the results of implementing the use of an interactive E-Module based on digestive system problems listed in Table 6 and the results of a student response questionnaire in Table 9 after learning to use an interactive E-Module based on digestive system problems, it can be interpreted that an interactive E-Module based on digestive system problems is feasible can be used and can improve critical thinking skills as well as mastery of students' concepts. The average student response felt helped by the existence of the E-Module, which made the learning process much more relaxed because of discussions with classmates, and without realizing it, they were getting used to solving problems, coupled with the appearance of the E-Module in the form of videos made students more interested compared to more monotonous textbooks. Some of the shortcomings that are noted in the implementation of this problem-based interactive E-Module include making it easier to access via cellphone with the same content because several video displays link must be played with a fairly strong quota for views

and questions as well as material and activities. The learning presented helps students understand the digestive system material and what is no less important is that because they are accustomed to solving problems in each learning activity, students indirectly feel used to solving problem-solving problems which are nothing but part of the process of critical thinking skills. The results of the implementation of the E-Module showed that the N-Gain of students' critical thinking skills was 0.82 with a good category and concept mastery was 0.77 with a good category. Based on the validation results of material experts, media experts, responses from science teachers and the N-Gain results, it can be concluded that the development of an interactive E-Module based on problems on the Digestive System material is feasible to use and is able to improve students' critical thinking skills and concept mastery.

Conclusion

Based on the results and discussion previously explained, several conclusions can be drawn. The characteristics of the problem-based interactive E-Module developed on the digestive system material are integrated with PBL syntax that is tailored to the student's ability equipped with material, learning activities, practice questions, and formative tests can be accessed easily using cellphones or laptops. Learning using problem-based interactive E-Modules can improve students' critical thinking skills and concept mastery with N-Gain scores in each high category for critical thinking skills and concept mastery. The results of student responses to the problem-based interactive E-Module on the digestive system material were categorized as very good with an average percentage of 89.67%.

Credit Authorship Contribution Statement

Prasetyorini: Coordinator Conceptualization, Methodology, Software, Visualization, Formal analysis, Writing – original draft, Writing – review & editing. **Rita Retnowati:** Director Conceptualization, Methodology, Software, Visualization, Formal analysis, Writing – original draft, Writing – review & editing. **Yuyun Yuliani:** Executor Conceptualization, Methodology, Formal analysis, Resources, Writing – review & editing, Supervision, Project administration.

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