Improving Students' Critical Thinking Skills Using e-Modules-Contextual Teaching and Learning (CTL) on the Interaction of Living Organisms with Their Environment

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Abstract

The ability to think critically is one of the 21st-century skills that students should master. Previous studies and international surveys such as PISA showed that the profile of Indonesian students' critical thinking skills is insufficient. This study developed e-modules based on Contextual Teaching and Learning (CTL) on the interaction of living organisms with their environment. The e-module was declared very feasible regarding its content, technological and assessment tools with 86.92%, 86.33%, and 93.5%, respectively. The readability test results by teachers and students were categorised as very feasible with 89,66 % and 88.08% percentages. The e-module was also tested empirically and demonstrated an improvement in students' understanding of the topic. The statistical procedures confirmed it, including the paired-sample t-test and the N-gain analysis.

Keywords: *E-module; Contextual Teaching and Learning (CTL); living organisms interaction; environment; critical thinking.*

I. Introduction

21st-century skills are an issue that is always discussed regarding adequate skills in education [14]. This skill is related to students' thinking process based on the reasoning stage, analysing a problem, gathering information, making hypotheses and expressing conclusions [28]. This relation is because critical thinking skills are important fundamental skills that students must have in facing real competition in the field, including students' ability to criticise problems related to learning

materials and real events in everyday life. Critical thinking skills have become the target and competence of educational goals [11]. Students who have mastered high critical thinking skills can integrate knowledge in terms of their skills, attitudes, and knowledge to create a good mindset in recognising problems. Applying science learning can develop students' critical thinking skills [2].

In the results Program for International Student Assessment (PISA) survey, Indonesia was ranked 73rd out of 79 countries that took part in the survey, with an average score of 379 [29]. The resulting score shows a decrease compared to 2015, when Indonesia ranked 65th out of 70 countries with a score of 386. This shows that students' skills related to critical thinking skills such as reasoning and solving problems of daily life still need to be developed in solving PISA questions. The results of research by [13] stated that teaching and learning activities have not been able to facilitate students in honing critical thinking skills, so 87% of students have difficulty understanding science material [13]. [6] also stated that teachers still dominate science's teaching and learning process as the main source of knowledge. This is because the teacher pursues the target subject matter set by the curriculum. This phenomenon is caused by teachers still focusing on learning outcomes that show indicators of student learning mastery. In contrast, students cannot explore knowledge and relate science concepts to everyday life. This impacts the concepts being taught that are still less meaningful and rote in nature, and students' low understanding of concepts causes students' process skills in critical thinking cannot to be honed to the maximum.

To overcome these problems, the government, through Permendikbud No.81a of 2013 concerning the Implementation of the 2013 Curriculum, has set a one-way learning pattern that only involves teacher and student interaction in multidirectional learning, which involves interaction between teachers, students, the community, the environment, as well as learning resources or media. This is expected to be able to change the pattern of learning from what was originally passive learning to be active, critical and innovative. Thus, learning should be student-centered (student centered learning). Student-centered learning also facilitates students in solving problems at a higher level (HOTS), one of which is the ability to think critically. Critical thinking has been considered in the curriculum.

One of the student-centred approaches is Contextual Teaching and Learning (CTL). This approach directs students to construct knowledge to improve their critical thinking skills [18]. The CTL approach can link the learning material learned in school with the facts, or reality students encounter daily. Linking problems in everyday life will give the advantage that the material learned at school can be well absorbed through the mature understanding that students get. Linking learning with facts in everyday life is an effective step because students interact with family, school,

community, and nature every day. In these interactions, many things related to science concepts can be learned at school.

Applying the CTL approach takes an intermediary or the right learning media to make it easier for teachers and students. One of the learning media that can be used is the module. The module is a learning device designed to contain material and evaluation for independent study [36]. In the world of education, technology has been developed to modify print modules into electronic modules or so-called e-modules. The development of the digital era allows the role of technology in learning so that the learning process will be more interesting for students.

The electronic module (e-module) is a set of learning made systematically and attractively according to the level of complexity to achieve the desired competence. Through electronic modules, students will be more motivated to learn to use specially designed features such as displaying images, animations, videos, and audio so that they can create fun learning. Electronic modules can be an online-based learning media solution because they are flexible and interactive [23]. In developing the module, the product made must support student self-learning (self-instructional), the presentation of material or activities is presented thoroughly (self-contained), and the developed module facilitates student learning without other learning media (stand-alone), linking it to everyday problems days that are actual and current (adaptive). The module is designed to be attractively suited to the age of junior high school students (user-friendly) [16]. [25] Developed chemo-entrepreneurship based manual book of chemistry to trigger students' entrepreneur skills.

Electronic modules (e-modules) are easy to carry and learn at any time without using a laptop or computer. Learning to use the module can be done anytime and anywhere according to needs. Electronic modules are characterised file by relatively small smartphones. The electronic module includes links that can help students browse recommended related materials. Electronic modules can also be equipped with animations, and video simulations and students can find out the completeness of their learning through interactive self-evaluation [12].

The module section is specifically designed based on CTL which includes: constructivism, questioning, learning community, modelling, and authentic assessment (Dewi & Primayana, 2019). The e-module also contains student activities or worksheets that apply investigations so students can be actively involved in activities and hone thinking skills [16]. In addition, in the evaluation section, the e-module also contains questions at the HOTS (Higher Order Thinking Skills) level with critical thinking indicators, according to Facione (2020), including interpretation, Inference, evaluation, analysis, explanation, and self-regulation. The six critical thinking indicators are also applied in the stages of the learning implementation plan.

In the context of science learning, the material for the interaction of living organisms with the environment is a material whose application is easy to find and contextual in everyday life. This is one of the materials taught in class VII SMP/MTs. From the analysis of the needs of students and teachers in science at SMPN 8 Malang, the researcher considers the need for various kinds of reading sources as the main guide for independent learning and honing critical thinking skills. Therefore, the researchers developed an e-module based on Contextual Teaching and Learning (CTL) to improve grade VII students' critical thinking skills on the interaction of living organisms with their environment. The e-module developed will be an interesting and interactive source of student reading because students are fully involved in the learning process such as video observations, actual reading texts according to events in daily life, problem-based worksheets, online quizzes that can be accessed on smartphones and online assignment collection will provide a non-boring student learning experience.

II. Method

The type of research used is pre-experimental research with the research subject of class VII F SMPN 8 Malang, totalling 30 students. This research adopts the research and development (R&D) method. The R&D method aims to test the effectiveness and produce a product. The research model used is a Four-D (4D) model with four stages: Define, Design, Develop, and Disseminate. In general, the development steps can be seen in Figure 1.

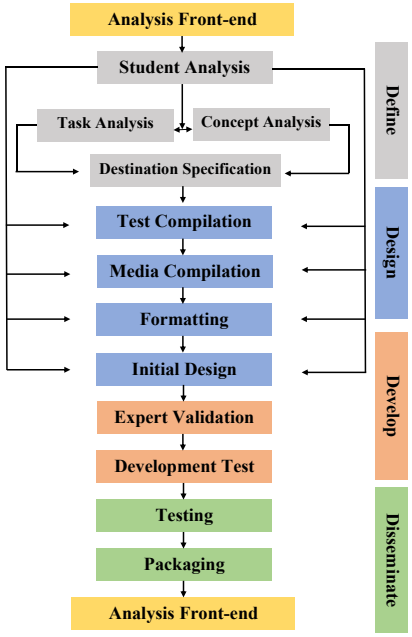


Figure 1. The flow of research on the development of learning media with a 4D model (Source: Thiagarajan, 1974)

In the development of e-modules, it begins with the definition stage, obtaining the following results:

1. Analysis of Front-end

Analysis Front-end is carried out to discover the problem as the subject of the development product. The analysis results based on interviews with science teachers and questionnaires on student needs at SMPN 8 Malang showed that the learning media used were science textbooks. This leads to the need for more interactive learning media. The media is expected to be a solution to learning problems amid the Covid 19 pandemic with the limitations of face-to-face learning.

2. Analysis of Student

Student analysis was carried out by examining the characteristics of students through direct observation. Based on researchers' observations at SMPN 8 Malang, the learning method used is still a direct instruction system. This indicates that the learning process of understanding concepts and critical thinking skills cannot be fully empowered. For this reason, teaching material is needed to improve students' critical thinking skills.

3. Concept analysis

This research uses material on the interaction of living organisms with their environment with the Contextual Teaching and Learning (CTL) learning model. The CTL approach can link the learning material learned in school with the facts, or reality students encounter daily.

The instruments used are material expert validation sheets, media expert validation sheets, question expert validation sheets, product readability questionnaires by teachers and students and multiple-choice questions instruments for pretest-posttest with critical thinking indicators. Data from expert validation will produce qualitative data and quantitative data. The results of qualitative data in the form of comments and suggestions are used as a basis for revising the developed media products. Quantitative data were collected using a rating scale of 1-4 and a Guttman 1/0 to assess the accuracy of the material. All quantitative data were processed using descriptive statistics.

Question instruments with critical thinking indicators were validated and tested empirically on 28 students of class VIII. Valid and reliable questions are used to determine the effectiveness of the e-module by providing a pretest, treatment, and post-test called One Group Pre-test, Post-test Design. Pretest and post-test data were analysed using a different test and N-gain. Pre-experimental design pretest, treatment, and post-test can be seen in Table 1.

Tabel 1.
Experimental Design, One Group Pretest Posttest

Pretest	Treatment	Posttest
O	X	O

(Source: Solihudin, 2018)

III. Results and Discussion

Description of E-module

The research product produced is an e-module based on Contextual Teaching and Learning (CTL) to improve the critical thinking skills of grade VII students on the topic of Interaction of Living organisms with their environment. The e-module was developed using the Flip PDF Corporate Edition by providing the product as an HTML link. As long as mobile devices are available, flipbook digital media can be accessed anytime and anywhere [24]. The e-module has been equipped with learning videos, texts, images, and student activity sheets along with links and QR codes and is connected to the google form. In education, QR codes can be an intermediary for alternative learning media, interesting and easy to scan [10]. E module also provides online that can be used as evaluation materials and pretest-posttest that are prepared with critical thinking indicators. An overview of the CTL-based e-modules that have been developed can be seen in Figure 2.

Figure 2. (a) *Cover* of e-modules (b) Display of content in e-modules

The e-module products are developed based on KD 3.7 and 4.7 class VII on the interaction of living organisms with their environment. The content presented in the e-module adapted to the CTL component includes constructivism, questioning, learning community, modelling, and authentic assessment (Dewi & Primayana, 2019). E-module is designed by dividing 1 KD into four learning activities. Each learning activity will begin with a "CTL Corner" description containing actual phenomena or events that can direct students to focus on giving examples in everyday life (modelling). In the "CTL Corner," there are texts, images and videos that can guide students in identifying, analysing, and observing certain events (inquiry). The existence of a video in this component aims to make the concept easy to understand, and the presentation of the concept is not boring. Video is good

to use as an introduction to learning activities [20]. After the CTL corner, there are questions in the "Critical Thinking" section, which guide students to explore problems so that they direct them to find material concepts (questioning). According to [27], solving real problems can increase students' critical thinking skills.

The activity is continued in the "Activity" section directing students to work together through discussion or carrying out various activities such as observation/observation and making understanding independently by constructing theory with understanding (Learning community & constructivism). At the end of each learning activity, there is a "Reflection Sheet", which allows students to review the material that has been understood and new things found today, the e-module also contains a summary of the material that has been studied (*reflection*). Reflection sheets also provide opportunities for students to assess themselves during the learning process, including assessing the attitudes shown during the learning process. The e-module also contains tests that can be used to assess student learning outcomes (*Authentic Assessment)*. This part of the reflection sheet makes it easier for students to know their learning progress [31]. CTL-based e-modules can assist students in associating academic learning with the context of everyday life, the environment and the real world so that students can understand the meaning of the understanding gained [9].

Material Expert Validation

Expert lecturers of Science Education validate the modules that have been developed. The material validation results include four aspects, as seen in Table 2.

Table 2.
Material Expert Validation

No	Rated aspect	Percentage (%)
1.	Eligibility of content on e-module	81,25%
2.	Eligibility of serving e-module	80,00%
3.	The suitability of the e-module with the Contextual Teaching and Learning (CTL) model	88,88%
4.	Material accuracy on e-module	97,56%
Average		86,92%

Based on the validation results, the average feasibility of e-module material based on Contextual Teaching and Learning (CTL) is 86.92%. This is included in the very feasible criteria [33]. The details of the feasibility of the e-module include: the feasibility of the content of 81.25%, the presentation of the material 80.00%, the suitability of the e-module with the CTL model of 88.8% and the accuracy of

the material in the e-module 97.56%. In content feasibility, there are inputs to pay attention to the questions in the "critical thinking" section of the "Environment" subsection by changing the questions, not only writing conclusions from readings and videos. According to [7], concluding is contained in the aspect of Inference with two other indicators, namely questioning facts and making alternatives. The revised question asks conclusions about biotic and abiotic components. Still, the desired answer is already contained in the text and video, so it cannot be categorised as a critical thinking question. Therefore, it is necessary to replace the questions according to the appropriate indicators.

In the aspect of presentation feasibility, the clarity of sentence usage gets a score of 2, and this is because there are several sentences about food webs and biomass pyramids which are considered less appropriate so that they need to be reworked using language that is easier for junior high school students to understand. The use of language in the preparation of e-modules must be simple and communicative [26]. Using simple language makes it easier for students to understand the material at the level of knowledge and age; thus, e-modules can support students' independent learning. Furthermore, in material accuracy, there is one concept that is not quite right according to the validator about an example of commensalism symbiosis: a shark and a remora fish. This is because if the remora fish is large, it will disturb the sharks, especially the small sharks. Small sharks need more energy to swim if the remora is attached to them. However, according to Bartlett, in his junior high school science module, the symbiosis between a shark and a remora fish is categorised as a commensalism symbiosis with a conceptual limitation, remora fish attaches to a shark or other larger fish [3]. The remora can eat the shark's leftovers and avoid predators, while the shark neither benefits nor is harmed. This interaction is developed in accordance with the boundaries of the desired concept.

Media Expert Validation

Furthermore, media validation is carried out by science education expert lecturers including feasibility in graphic aspects, language feasibility and usage aspects. The percentage of validation results can be seen in Table 3.

Table 3.

Media Expert Validation Results

No	Rated aspect	Percentage (%)
1.	Aspects of the feasibility of graphics	84%
2.	Aspects of language eligibility	75%
3.	Aspects of use	100%
Average		86,33%

Based on the results of media expert validation, an average of 86.33% was obtained so that it could be categorised as very feasible [33]. The average is obtained from several aspects, which are assessed with details of the feasibility aspect of graphic 84%, language feasibility aspect 75% and usage aspect 100%. In the aspect of graphic feasibility, the e-module received a revision on the cover to rearrange the writing location of the developer's name, delete double-written text, and consistently write the name of the developer and supervisor (uppercase or capitalise each word) to make it look more proportional. According to [22], the e-module cover's function is converted to attract attention so that readers are interested in using the module. Furthermore, regarding language feasibility, the e-module received a revision to re-correct the writing to use proper and appropriate punctuation. Improvements in language feasibility are in accordance with the characteristics of the module, namely, user-friendly. Every instruction that helps the user is easy to understand, and the use of appropriate grammar and spelling are user-friendly characteristics of the developed product [26]. The comments and inputs by these experts are used as material for revision to improve the e-module.

Question Validation

Before the empirical test, an expert lecturer in Science Education carried out the instrument validation test with critical thinking indicators. Of the 30 questions that were validated, an average of 93.5% was obtained so that it could be categorised as very feasible with editorial revisions or sentence composition on eight numbers out of 30 questions. After being validated, the questions were empirically tested on 26 students who had received material on the interaction of living organisms with their environment. The questions that have been empirically tested are tested for validity with Pearson correlation analysis using SPSS in Table 4.

Based on the empirical test, 16 questions are categorised as valid with a percentage of 53.3%. R count for valid questions ranges from 0.405-0.795 with a comparison of R table for 26 respondents is 0.388 so that R count > R table can be categorised as valid. Meanwhile, there are 14 invalid questions with a percentage of 46.7%, which are not used in the pretest and post-test. The validated questions are in the C4-C6 cognitive domain and are based on critical thinking indicators. Critical thinking indicators, according to Facione are: interpretation shows the ability of students to understand, explain, and give meaning to a piece of information or problem. Second, Inference is the ability of students to identify certain elements to draw logical conclusions.

Table 4.

Validity Results of Valid Question Instruments

Empirical Validity	Question category	
	Valid	Invalid
Number of questions	16	14
Percentage	53,3%	46,7%
R count	0,405-0,795	-0,297-0,364
Question item number	2, 8, 11, 12, 13, 15, 16, 19, 21, 22, 23, 24, 25, 28, 29, 30	1, 3, 4, 5, 6, 7, 9, 10, 14, 17, 18, 20, 26, 27

The third evaluation shows the appropriate strategy for accepting or rejecting opinions. The fourth analysis shows the ability of students to find relationships based on information - information used to express new thoughts or opinions. The fifth explanation shows the ability of students to provide further explanations of the results of thinking based on evidence. Sixth, self-regulation shows the ability of students to re-correct the arguments that have been submitted [7]. Based on these indicators, the number of questions with valid critical thinking indicators based on empirical tests, namely Inference as many as 1 item, Self-regulation indicator 1 item and Analysis indicator as many as 14 items. The percentage of the distribution of questions with critical thinking indicators is described in the diagram Figure 3.

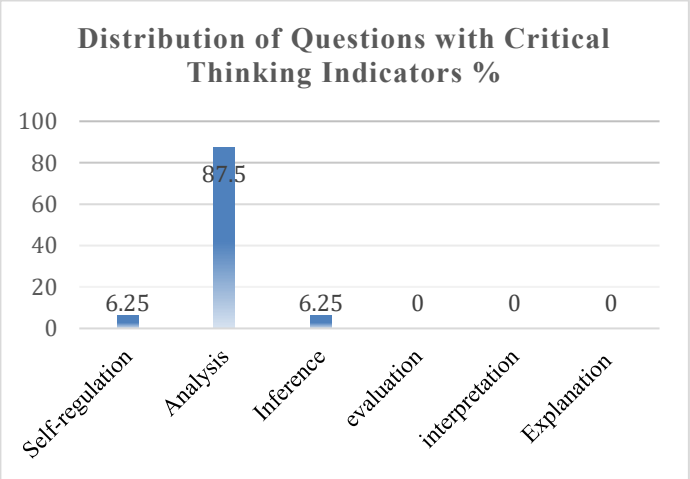


Figure 3. Diagram of the distribution of questions with critical thinking indicators

The spread of valid questions only represents 3 out of 6 critical thinking indicators. The highest percentage of questions in the analysis indicator is in the cognitive domain of C4, 62.5%. This already

represents the indicators of critical thinking. Most junior high school students will have difficulty solving questions in C5 and C6; therefore, valid questions based on empirical tests are dominated by C4 with analysis indicators. The unequal distribution of questions was since when the empirical validity was tested, several questions with evaluation, interpretation and explanation indicators were declared invalid, so the questions could not be used in the pretest and post-test. Valid questions based on this empirical test are then tested for reliability. The results of the reliability test can be seen in Table 5.

Table 5.

Item Reliability Analysis

Reliability Analysis	Value of Sig.	Criteria
	0,869	High

The reliability test results calculated using SPSS.16 showed the results of sig. 0.869 with the criteria of "high". These criteria are based on the opinion of Anas (2019), who states that if the results of the reliability test show 0.70, the question instrument can be categorised as having a high-reliability value (reliable), whereas if the reliability test shows a score of < 0.70 then the test instrument has high reliability. low (un-reliable) (Anas, 2019). Calculating the reliability of the question aims to determine the accuracy or accuracy of the measuring instrument used as evaluation material. The higher the reliability value of a test instrument, the higher the accuracy of the instrument used [30]. The factors that influence the results of this reliability test include the number of questions and the ability of students to work on the questions themselves.

Readability Test

The product and instrument were revised, and the product in the form of a CTL-based e-module was tested for readability by science teachers and students with a total of 25 respondents. The readability test results can be seen in Table 6 and Table 7.

Table 6.

E-module Readability Results by Science Teachers

No	Rated aspect	Percentage (%)
1.	Interest	83.3%
2.	Theory	75%
3.	Language	100%
4.	Appearance	90%
5.	Use	100%
Average		89.66%

Table 7.

E-module Readability Results by Students

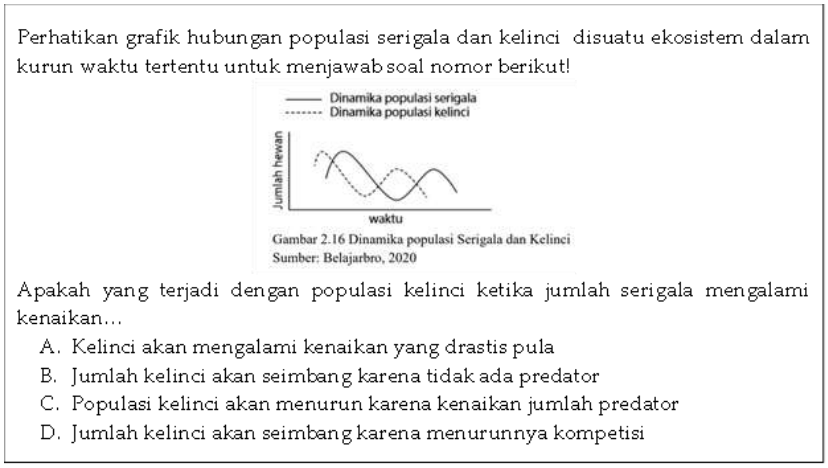
No	Rated aspect	Percentage (%)
1.	Interest	87%
2.	Theory	82.5%
3.	Language	91%
4.	Appearance	89.6%
5.	Use	90.3%
Average		88.08%

The average gain was obtained from several assessed aspects, including the interesting aspect of 83.3%, the material aspect of 75%, the language aspect of 100%, the display of 90% and the usage aspect of 100%. Based on the readability of one science teacher at SMPN 8 Malang, the average percentage was 89.66% so it can be categorised as very feasible [33]. In contrast, the results of the readability test by 25 students obtained an average percentage of 88.08%. The value is obtained from the interest aspect 87%, material aspect 82.5%, language aspect 91%, display 89.6% and usage aspect 90.3%. Based on this readability test, CTL-based e-modules are very suitable to be used in the learning process. This is in line with another research which states that contextual-based e-modules are very good for learning [21].

Paired Sample T-Test

CTL-based e-module (pretest) and after using the e-module (post-test). After the product and instrument are ready to be used, treatment is given in the form of using e-modules based on Contextual

Teaching and Learning (CTL) in science learning with research subjects of 30 students of class VII F. Questions that have been declared valid and reliable are used in analysing the success of indicators before using the product. The average pretest value is 62.92, while the post-test value is 83.33. This shows that the results obtained after treatment increased by 24.5%, so there is a difference in the average learning outcomes between the pretest and post-test. Examples of questions that are done by students in the pretest and post-test on the analysis indicator with a graphic stimulus can be seen in Figure 4.


Perhatikan grafik hubungan populasi serigala dan kelinci disuatu ekosistem dalam kurun waktu tertentu untuk menjawab soal nomor berikut!

Gambar 2.16 Dinamika populasi Serigala dan Kelinci
Sumber: Belajarbro, 2020

Apakah yang terjadi dengan populasi kelinci ketika jumlah serigala mengalami kenaikan...

A. Kelinci akan mengalami kenaikan yang drastis pula
B. Jumlah kelinci akan seimbang karena tidak ada predator
C. Populasi kelinci akan menurun karena kenaikan jumlah predator
D. Jumlah kelinci akan seimbang karena menurunnya kompetisi

Figure 4: Example Questions with Analysis Indicators

This problem presents a graph of the relationship between species populations in an ecosystem. The student's task is to analyse the possibilities due to population dynamics in that ecosystem. The pretest results showed that 36.6% of students answered correctly, while in the post-test, there was an increase, namely 24 out of 30 or 80% of students answered correctly. This proves that using e-modules facilitates students in improving their ability to answer questions.

Furthermore, the pretest and post-test data were tested for normality as a prerequisite to showing the sig value. The pretest and post-test are 0.257 and 0.006, respectively, so that the sig value > 0.05, the data can be normally distributed. After confirming that the data were normally distributed, the paired sample t-test was carried out, as stated in Table 8.

Table 8.
Paired Sample T-Test Results

Group	Average	Sig.	Criteria
Pretest	62,92	0,000	Significantly different
Posttest	83,33		

Based on Table 8, it can be seen that the indicators of the success of this research are indicated by the output of the t-test in Table 8, which shows the value of sig. (2-tailed) is 0.000 < 0.05, so H0 is rejected and H1 is accepted. This means that there is a significant difference in the pretest and post-test scores, so there is an effect of using e-modules based on Contextual Teaching and Learning (CTL) in increasing the critical thinking skills of class VII F students on the topic of the interaction of living organisms with their environment. A similar study was produced by [6], which showed a significant difference in students' conceptual understanding facilitated by the CTL module.

Effectiveness Test

Furthermore, to determine the effectiveness of using CTL-based e-modules, the N-Gain test was carried out in a one-group pretest-posttest design with 30 samples; the results of the pretest and post-test can be seen in Table 9.

Table 9.
N-gain test results

Group	N gain score	Criteria	N Gain %	Criteria
Pretest Posttest	0,57	medium	57,13	Effective enough

The N-gain analysis shows that the N gain is 0.57, which is in the interval 0.7 > 0.3, so it is in the "medium" criteria [19]. The N-gain per cent shows a value of 57.13%; in this case, the development of e-modules based on Contextual Teaching and Learning (CTL) is in the "quite effective" category used to improve critical thinking skills [15]. This is in line with Hasanah's opinion that the science module can improve students' critical thinking skills if packaged based on CTL components [16]. Similar research shows that CTL-based learning effectively improves students' skills, in this case, critical thinking skills [4], [34]. The final stage in the development of this e-module is the dissemination stage. The distribution of e-modules is carried out on a small scale, including the introduction of CTL-based e-modules to science teachers at SMP N 8 Malang to be used as electronic teaching materials for class VII on the topic of Interaction of Living organisms with their environment

IV. Conclusion

The results of this study indicate that the e-module is stated in the very feasible category based on the validation of material experts, media experts and questions experts with percentages of 86.92%,

86.33%, and 93.5%, respectively. The E-module is equipped with questions with valid and reliable critical thinking indicators with an R count ranging from 0.405-0.795 and a significant value of 0.869 in high-reliability criteria. The readability test results by teachers and students were categorised as very feasible, with a percentage of 91.3% for teachers and 88.08% for student readability. The empirical test results show a significant difference in the pretest and post-test scores, indicating the effect of using e-modules based on Contextual Teaching and Learning (CTL) in improving students' critical thinking skills. The N-gain of 0.57, which is in the interval of 0.7 > 0.3, indicates that the e-module based on Contextual Teaching and Learning (CTL) is in the "quite effective" category used to improve critical thinking skills.

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