



Development of SETS-Based E-Modules to Measure Students' Critical Thinking Ability in Buffer Solution Material

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Abstract: Development of SETS-Based E-Modules to Measure Students' Critical Thinking Ability in Buffer Solution Material. This study aims to 1) Find out the results of the needs analysis of the E-Module developed at SMA Negeri 1 Percut Sei Tuan, 2) The eligibility level of the SETS-based E-Module based on the BSNP assessment, 3) The response of teachers and students to the SETS-based e-module on buffer solution materials, and 4) Students' critical thinking skills towards SETS-based e-modules on buffer solution materials. The subjects in this study were 2 material expert validators, 2 media expert validators, 2 chemistry teachers and 30 students of class XI IPA. The instruments used were chemistry teacher interview guidelines, needs analysis questionnaires, teacher and student response questionnaires and E-Module feasibility questionnaires according to BSNP standards. This research uses the development method (R&D) with the 4D model (Define, Design, Develop, and Disseminate). The results show 1) the needs analysis states that students need teaching materials in the form of SETS-based E-Modules as supporting teaching materials, 2) the level of eligibility according to BSNP standards by material experts and media experts obtains an average score of 89,6% with very high criteria, 3) the response of the chemistry teacher obtained an average score of 88,21% with very interesting criteria, and 4) the results of students' critical thinking abilities after using the SETS-based E-Module obtained an average score of 78,05 above the KKM which indicated that the application of this media already very good.

Kata Kunci: E-module, SETS, Critical Thinking Ability, Buffer Solution

Abstrak: Pengembangan E-Modul Berbasis SETS Untuk Mengukur Kemampuan Berpikir Kritis Siswa Pada Materi Larutan Penyangga. Penelitian ini bertujuan untuk 1) Mengetahui hasil analisis kebutuhan E-Modul yang dikembangkan di SMA Negeri 1 Percut Sei Tuan, 2) Tingkat kelayakan E-Modul berbasis SETS berdasarkan kriteria penilaian BSNP, 3) Respon guru dan peserta didik terhadap e-modul berbasis SETS pada materi larutan penyangga, dan 4) Kemampuan berpikir kritis peserta didik terhadap e-modul berbasis SETS pada materi larutan penyangga. Adapun subjek dalam penelitian ini adalah 2 validator ahli materi, 2 validator ahli media, 2 guru kimia dan 30 siswa kelas XI IPA. Instrumen yang digunakan adalah pedoman wawancara guru kimia, angket analisis kebutuhan, angket respon guru dan siswa serta angket kelayakan E-Modul sesuai dengan standar BSNP. Penelitian ini menggunakan metode pengembangan (R&D) dengan model 4D (Define, Design, Develop, dan Disseminate). Hasilnya menunjukkan 1) analisis kebutuhan menyatakan bahwa siswa membutuhkan bahan ajar berupa E-Modul berbasis SETS sebagai penunjang bahan ajar, 2) tingkat kelayakan sesuai standar BSNP oleh ahli materi dan ahli media memperoleh nilai rata-rata 89,6 % dengan kriteria sangat

tinggi, 3) respon guru kimia memperoleh nilai rata-rata 88,21 % dengan kriteria sangat menarik, dan 4) hasil kemampuan berpikir kritis siswa setelah menggunakan E-Modul berbasis SETS memperoleh nilai rata-rata 78,05 diatas KKM yang menandakan bahwa penerapan media ini sudah sangat baik

Kata kunci: E-modul, SETS, Kemampuan Berpikir Kritis, Larutan Penyangga

▪ INTRODUCTION

Based on Law no. 20 of 2003, in essence the purpose of national education is to develop the self-potential of students so that they have faith and piety, have noble personality, have noble character, and be independent. Indonesia realizes the importance of noble character being prioritized in the education process. This is stated in article 36 of Law no. 20 of 2003 which contains references in the preparation of curriculum operations. These references include increasing faith and piety, increasing noble character, increasing the potential, intelligence, and interests of students (Amrullah Aziz, 2017).

The 2013 curriculum or often known as K13 is a curriculum that guides students to have three competencies namely character, insight and skills (affective, cognitive and psychomotor). In applying K13 students are asked to be active and imaginative in solving problems (Dalimunthe, 2022). Along with technological developments, of course, it has a big impact in all fields, including Chemistry. In chemistry there is matter which includes the composition, properties, and changes in matter and the energy that accompanies it. It is this abstract and complex nature that makes the implementation of Chemistry learning must be supported by learning media. Technology-based media makes students adapt to the current development of the times. If students are accustomed to using IT-based media, indirectly the learning process will also develop their thinking skills (Silaban, 2021).

Permendiknas N0. 23 2006 stated that Standard Criteria for Graduates of the Education Unit (SKL-SP) in chemistry subject at SMA/MA/SMK equivalent is a mandatory student have the ability to think like that ability to think logically, analytically, systematic, critical and creative, as well have the ability to work together. Of the five thinking skills critical thinking skills included in standard criteria for graduates who must have by high school students (Hajijah, 2019). Critical thinking ability is one of the abilities that must be achieved in the learning process. This is in accordance with Permendikbud Number 23 of 2016 concerning assessment standards. However, in reality students' thinking skills are still relatively low. This can be seen from the Program for International Student Assessment (PISA) survey in 2015 that the average score of students' scientific abilities in Indonesia is 403. Where the score set is 493, so it can be seen that the level of students' critical thinking skills is relatively low (Desni , 2019). Critical thinking skills are trained with a purpose prepare students to be able to deal with various situations in life is always faced with various problems and choices as well life situations that are constantly changing. through education, students are prepared to become problem solvers until they are capable make a decision about what to believe. Important for students have critical thinking skills to make it easier for students to solve the questions/questions that the teacher gave or choose the correct answer the most appropriate of the many options available (Merianti, 2016).

Based on the results of observations at SMA Negeri 1 Percut Sei Tuan that students experience difficulties in understanding chemistry which is characterized by low

thinking skills during the learning process so that students' chemistry scores do not reach the specified KKM. This happens because the model used by the teacher during the learning process is only the lecture or teacher center method, where the learning process is only centered on the teacher. In addition, the teaching materials used are only sourced from textbooks provided by the library. Where the package books given tend to be heavy and too much writing. If the learning model and teaching materials used are less effective, it will certainly cause boredom and will not attract students' interest in learning chemistry.

E-module is a learning resource that focuses on a particular topic and is packaged in Web form, so that it can be studied anytime and anywhere via the internet or certain sites (Rahayu, 2019). E-module is an application of independent learning resources that aim to improve students' competence and understanding. E-modules can be made using various functions and applications so that e-modules have advantages over textbooks (Fadhillah, 2019). The advantages of e-modules are that they are easy to carry anywhere, do not require paper and ink, so they are cheaper and easier to implement (Romayanti, 2020).

The development of E-modules with the SETS (Science, Environment, Technology and Society) approach is a combination that involves elements of science, technology, society and society. SETS learning is very suitable when used in learning related to everyday life and has a close relationship with technological developments. This approach also provides direct experience so that it motivates students (Khasanah, 2019).

Previous research regarding the development of SETS-based E-modules to improve students' critical thinking skills had been carried out by (Nisa, 2022), after using the products developed, students experienced increased critical thinking skills. The effectiveness of the product being developed was also determined from the student response questionnaire which consisted of interest, material, and language reaching 89% in the very good category.

▪ **METHOD**

The research design used in this research is research and development (R&D). This study uses a quantitative approach and test instruments to measure critical thinking skills in the buffer solution material. The 4D development model is used in this research. Thiagarajan, et al (1974), states that the 4D model consists of 4 stages, namely defining, designing, developing, and disseminating.

1) Define Stage

The define stage is a stage that includes the activities of defining the product being developed along with its definitions and specifications. Initial final analysis in the form of problem analysis to alternative analysis that can be developed to solve problems, student analysis, task analysis, and concept analysis. This stage is carried out for literature studies in books, journals, and other references.

2) Design Stage

At this stage, the development process is carried out through the results of the needs analysis on the research and information gathering that has been carried out which can be used as a reference in the preparation of the SETS-based electronic module design on buffer solution material.

3) Development Stage

The development of the e-module must be based on several aspects such as the criteria for a good e-module and the adjustment of the e-module to the learning material. Furthermore, the e-module will be validated by an expert validator. Validation is carried out by 2 experts, namely 1) the material expert will validate the product to be developed, the context of the material, the design and the images and videos presented 2) the learning media expert who will validate the product so that it is in accordance with the learning standards to be achieved.

4) Deployment Stage

This dissemination stage is the stage of using the learning tools that have been developed. This research was conducted at SMA Negeri 1 Percut Sei Tuan which is located at Jalan Irian Barat, Sampali Village No. 37 Medan Estate, Kec. Percut Sei Tuan Kab. Deli Serdang Province of North Sumatra. The time of the research was carried out from January - May 2023 even semester of the 2022/2023 academic year. The sample used was 30 students of class XI IPA SMA Negeri 1 Percut Sei Tuan.

▪ RESULT AND DISCUSSION

1) Results of the Defining Stage (Define)

Based on the results of the needs questionnaire which was distributed to 30 students of class XI IPA at SMA Negeri 1 Percut Sei Tuan, it was found that as much as 87% of students had never used electronic-based teaching materials. In addition, students have never used SETS (Science, Environment, Technology and Society)-based teaching materials on the subject of buffer solutions. Then as many as 100% of students agreed to develop SETS (Science, Environment, Technology and Society)-based teaching materials to train their critical thinking processes.

From the results of the needs analysis that has been carried out, it can be concluded that class XI IPA students at SMA Negeri 1 Percut Sei Tuan need teaching material products in the form of modules packaged in electronic form that are able to attract students' attention in learning so that students have an interest in learning buffer solutions and are able to improve students' critical thinking processes.

2) Results of the Design Stage (Design)

The stages in this study consist of stages. Namely the selection of material, questions and format selection in accordance with SETS (Science, Environment, Technology and Society)-based e-module development research procedures.

▪ Material selection

The e-module is composed of material titles, KI, KD, learning objectives, instructions for using e-modules, learning activities, SETS (Science, Environment, Technology and Society) based learning materials, videos and learning images related to buffer solutions, critical thinking questions (C4 and C5) as well as several book supplements such as glossaries and summaries.

▪ Format selection

The format used in the e-module is a format that meets the criteria of interest, helps and makes it easier to carry out learning, which has layout designs, writing, pictures and

videos. The description of the SETS (Science, Environment, Technology and Society)-based e-module design format made by researchers will be in more detail on the aspects that are focused on, namely:

1. Cover Design

The cover design displayed on the e-module uses images related to the buffer solution material. Accompanied by a title that has a font size large enough for the title section and slightly smaller for other writing sections (researchers, supervisors, book class goals, etc.), added the Unimed logo and a bright or full color cover color so that on the cover there is harmony between the writing with pictures.

2. Content Design

The e-module has a SETS (Science, Environment, Technology and Society) based content design using a font size of 12 with Times New Roman, Calibri and Arial. The text contained in the e-module is also given a customized color to enhance the appearance and attract attention in the process. In addition, in the e-module there is also a video that can be played. There are pictures related to buffer solutions, as well as the application of buffer solutions in science, technology, society and society. The e-module also contains examples of questions and practice questions.

3) The Results of the Development Stage

From the results of the e-module design and development stage, one product can be produced, namely SETS (Science, Environment, Technology and Society) based e-module. On page iv there are characteristics of the SETS approach module, so that users know how the SETS model works. Then, on page there are instructions for using the e-module for teachers and students. The next page is the module identity section, core competencies, basic competencies, indicators, and learning objectives. On page 1 there is a concept map that has been included in learning buffer solutions. SETS (*Science, Environment, Technology and Society*) stages: In the preliminary stage the e-module displays information about buffer solutions in the human body and is followed by practical exercises carrying out simple practicum. The next stage is concept formation, the e-module displays an explanation of buffer solutions ranging from understanding to application of buffer solutions in life. At this stage there are pictures and several videos to support students' understanding of buffer solutions. At the application stage of the concept of buffer solutions in everyday life, the e-module displays the role of buffer solutions in life. Applications of buffer solutions are described using pictures and videos ranging from applications in science, technology, society and society. At the stabilization stage, the e-module displays a competency test, where the questions listed are questions that have been validated by chemistry lecturers who have indicators of critical thinking (C4 and C5). At the assessment stage in the e-module, it is shown how to evaluate after working on and checking answers after working on competency test questions.

Table 1: Material Validation Assessment Results

Assessment Aspects	Average Percentage (%)		Percentage (%)
	Validator I	Validator II	
Content eligibility	94	87	90,5

Presentation eligibility	88,8	82,2	85,5
Contextual Assessment	88,8	80	84,4
Percentage (%)			86,8
Percentage interpretation			Very high
Eligibility criteria			Valid/Eligible

Based on Table 1, the results of material validation by two chemistry lecturers at FMIPA, Medan State University, it can be seen that the results of the average percentage obtained were 86.8%. It can be stated that the SETS (*Science, Environment, Technology and Society*) based e-module shows an average score of "very high" and the average score shows the criteria of "decent" based on the BSNP.

Table 2: Media Validation Assessment Results

Assessment Aspects	Average Percentage (%)		Percentage (%)
	Validator I	Validator II	
Graphic Eligibility	97	93,3	95,15
Language Eligibility	96,6	88,3	92,45
Percentage (%)			93,8
Percentage interpretation			Very high
Eligibility criteria			Valid/Eligible

Based on table 2, it can be seen that the average percentage of media validation results is 93.8% which indicates that the SETS (Science, Environment, Technology and Society)-based e-module on the subject of buffer solutions to measure students' critical thinking skills can be categorized as "decent " in accordance with the BSNP assessment criteria.

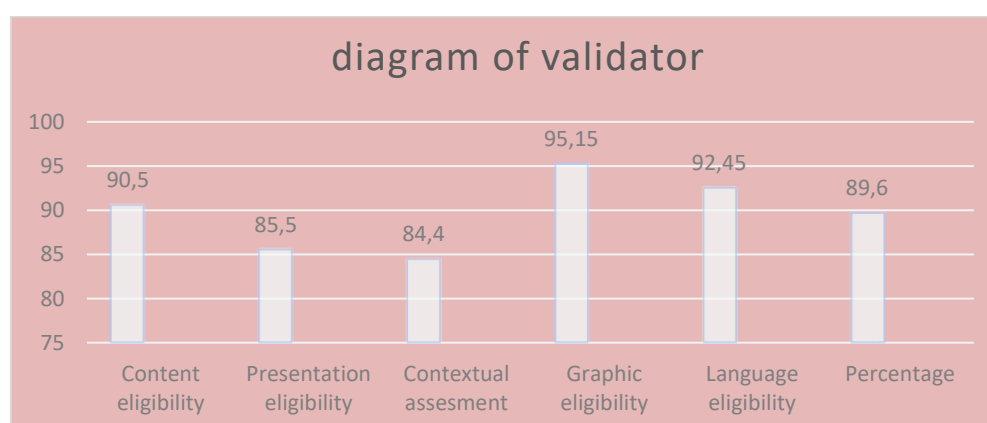


Figure 1. Overall average percentage chart

Based on Figure 1, it can be seen regarding the overall assessment by the validator of the e-module product based on the BSNP standard which was validated by 2

material expert lecturers and 2 media expert lecturers. It can be seen that the average percentage of eligibility is 89.6% with proper validation criteria. There are several suggestions and input from material expert validators so that the e-module is designed even better. The following is a summary of suggestions and input in table 2. And after being given suggestions for improvement, then the next step is to revisi the E-module

Table 2. Suggestions and Input from Material Expert and Media Expert Validators

Suggestions and Input Material Expert Validators	
Validator I	Validator II
1. Fix the concept map, it must have connecting words between concepts	1. Add another concept or definition of buffer solution
2. References from images and videos have not been listed	2. Add an answer key
Media expert validator advice and input	
Validator I	Validator II
1. Adjust the color of the sample question box	1. The page should be at the bottom right
2. Tidy up the position of the writing	2. The title of the e-module on each page is placed at the top only

Before :

MODUL LARUTAN PENYANGGA BERBASIS SETS

PETA KONSEP

1

Modul Larutan Penyangga Berbasis SETS (science,environment, technology, and society)

CONTOH SOAL !

Diketahui K_a asam laktat $= 10^{-4}$

Perbandingan konsentrasi asam laktat ($\text{CH}_3\text{CHOHCOOH}$) dan Na-laktat ($\text{CH}_3\text{CHOHCOONa}$) agar dihasilkan pH larutan 4 adalah.....

Jawab :

$$\begin{aligned} \text{pH campuran} &= 4 \\ K_a &= 10^{-4} \\ \text{pH} &= -\log \text{H}^+ \\ 4 &= -\log \text{H}^+ \\ \text{H}^+ &= 10^{-4} \\ [\text{H}^+] &= K_a \times \frac{\text{asam lemah}}{\text{base konjugasi}} \\ [10^{-4}] &= 10^{-4} \times \frac{\text{asam lemah}}{\text{base konjugasi}} \\ \frac{\text{asam lemah}}{\text{base konjugasi}} &= \frac{1}{1} \end{aligned}$$

Perhatikan video dibawah ini !

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MODUL LARUTAN PENYANGGA BERBASIS SETS

APLIKASI DALAM LINGKUNGAN

Pengurangan Limbah Air Grey Water (GW)

Secara kimiawi, air yang berkualitas baik adalah yang memiliki pH netral tidak mengandung bahan berbahaya dan beracun baik dari kandungan logam atau bahan organik. Namun sekarang tak jarang kita menjumpai pencemaran air, terutama di daerah padat penduduk. Salah satu penyebab pencemaran air yang terjadi disebabkan oleh sampah organik dan anorganik, limbah industri, dan limbah rumah tangga yang dibuang secara sembarangan.

Limbah industri dan limbah rumah tangga yang berupa, limbah padat (botol minuman, plastik, dan lainnya), limbah organik (sisa sayuran yang dapat menimbulkan bau tidak sedap), dan limbah zat kimia yang ditemukan pada sabun, detergen, shampo, dan bahan pembersih lainnya yang dapat meningkatkan pH di lingkungan air sehingga dapat mengganggu ekosistem didalamnya.

Pencemaran air telah menunjukkan gejala yang cukup serius, terutama yang berasal dari buangan industri dari pabrik-pabrik yang membuang secara sembarangan ke air atau darat tanpa pengolahan lebih dahulu. Kondisi tersebut juga diperburuk dengan rendahnya kesadaran masyarakat yang membuang kotoran maupun sampah kesungat, dimana hal ini akan mempercepat terjadinya pencemaran dalam. Pencemaran air memberikan dampak yang buruk diantaranya ketidakseimbangan ekosistem di air. Menjadi sarang wabah penyakit yang tentunya memberikan kerugian bagi seluruh masyarakat.



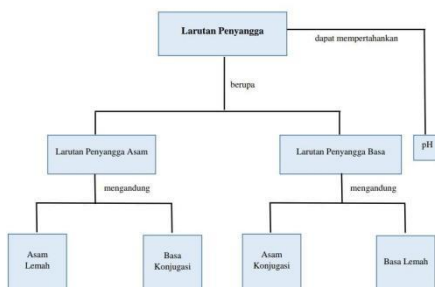
cantumkan sumber foto

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After :

Modul Larutan Penyangga Berbasis SETS (science,environment, technology, and society)

PETA KONSEP



1

Modul Larutan Penyangga Berbasis SETS (science,environment, technology, and society)

CONTOH SOAL !

Diketahui K_a asam laktat $= 10^{-4}$

Perbandingan konsentrasi asam laktat ($\text{CH}_3\text{CHOHCOOH}$) dan Na-laktat ($\text{CH}_3\text{CHOHCOONa}$) agar dihasilkan pH larutan 4 adalah.....

Jawab :

$$\text{pH campuran} = 4$$

$$K_a = 10^{-4}$$

$$\text{pH} = -\log H^+$$

$$4 = -\log H^+$$

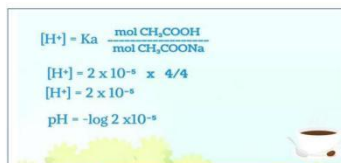
$$H^+ = 10^{-4}$$

$$[H^+] = K_a \times \frac{\text{asam lemah}}{\text{Basa Konjugasi}}$$

$$[10^{-4}] = 10^{-4} \times \frac{\text{asam lemah}}{\text{Basa Konjugasi}}$$

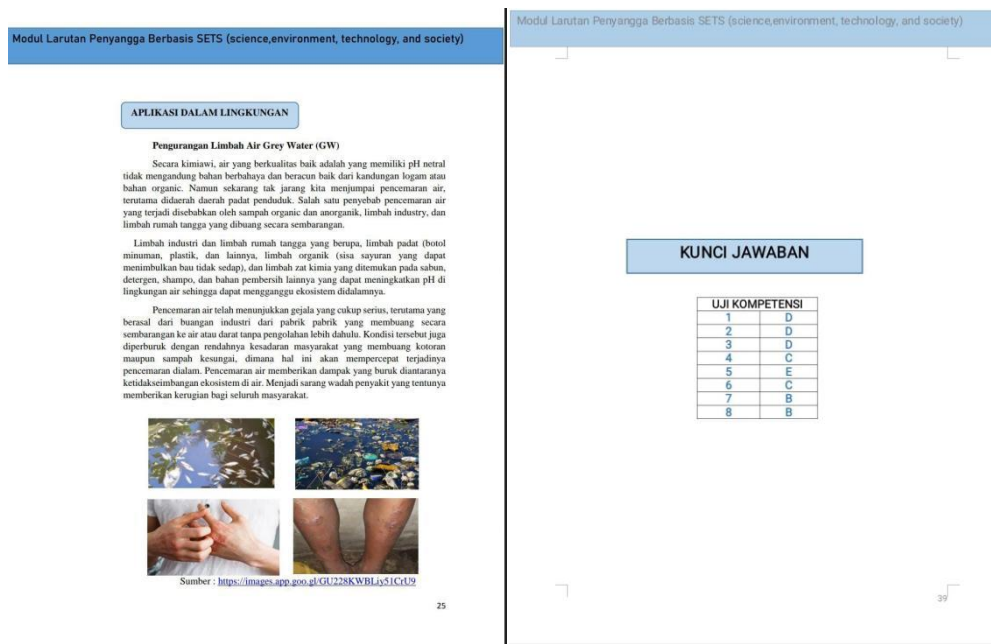
$$\frac{\text{asam lemah}}{\text{Basa Konjugasi}} = \frac{1}{1}$$

Perhatikan video dibawah ini !



<https://youtu.be/XAcNvg4dYjM>

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4) Results of the Deployment Stage

At the distribution stage it was carried out in class XI IPA SMA Negeri 1 Percut Sei Tuan by distributing e-module products using e-module links sent to students which were accessed online via the internet. Next, 2 chemistry teachers and 30 students responded to the SETS (Science, Environment, Technology and Society) based e-module on the subject of buffer solutions. The validation and response instruments used use a Likert scale.

Table 4: Chemistry Teacher Responses

On Aspect	Average Percentage (%)		Percentage (%)
	Teacher I	Teacher II	
Material	82,85	85,71	84,28
Presentation	91,42	94,28	92,85
Language	85	90	87,5
Percentage (%)			88,21
Questionnaire Results Interpretation Criteria			Very interesting

As for the results of the responses from 2 chemistry teachers on the questionnaire sheets given, it was obtained that teacher I obtained an average percentage of 86.42%. As for the second teacher's response, it obtained an average of 89.99%. Based on the responses from the two chemistry teachers at SMA Negeri 1 Percut Sei Tuan, an average percentage of 88,21% was obtained which was categorized as very attractive qualification. This shows that e-modules developed and validated by material and media experts are e-modules which, when used as learning resources, will be very attractive to students.

Table 5: Student Responses

On Aspect	Average Percentage (%)
Material	82,57
Appearance	89,66
Benefit	89,99
Percentage	87,40
Criteria for Interpretation of Questionnaire Results	Very interesting

The researcher gave a questionnaire to be filled out by 30 students of class XI IPA to find out the response to the e-module. Based on the field test obtained on the feasibility aspect of the material obtained an average percentage of 82,57%, the viewability aspect obtained an average percentage of 89,66% and the eligibility aspect obtained an average percentage of 89,99%. So that from all aspects given an average percentage of 87,40%, so that the student's response shows that the e-module product developed is in the very attractive category for students.

Table 6: The average percentage of students' critical thinking skills

Critical Thinking Ability	Number of Questions	Average Value of Students' Critical Thinking Ability
Analyze	6	79,44
Evaluate	2	76,66
Average Percentage (%)		78,05

In carrying out the trial, the researcher provided an e-module link to 30 students so that they could be accessed individually via smartphone. Next, let students operate the e-module. The scores obtained from students to measure students' critical thinking skills can be seen in table 6. Critical thinking skills are considered very good because the values obtained from 30 students on average are above the KKM (75), namely with an average value of 78,05.

▪ CONCLUSION

Students' critical thinking skills after using e-module based SETS (Science, Environment, Technology and Society) obtained an average score of above 75 KKM is 78,05. It means E-module based SETS (Science, Environment, Technology and Society) can measure students' understanding of critical thinking at SMA Negeri 1 Percut Sei Tuan so that learning does not only come from the textbooks provided by the party schools and learning are no longer only focused on the teacher but rather will involve students directly and increase mastery special material buffer solution.

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