

**DEVELOPMENT OF E-MODULES BASED ON DISCOVERY
LEARNING ON CRITICAL THINKING SKILLS
PHYSICS STUDENTS IN
CLASS X SMA/MA**

Emilia Fadillah^{1*}, Media Roza², dan Pipi Deswita³

Universitas Islam Negeri Imam Bonjol Padang

[*fadillaemilia64@gmail.com](mailto:fadillaemilia64@gmail.com), mediaroza@uinib.ac.id, pipideswita@uinib.ac.id

Articel Received: xx/xx/xxxx; **Accepted:** xx/xx/xxxx

ABSTRACT

The purpose of the research is to produce Discovery Learning-based E-Modules that are valid, and practical towards the critical thinking skills of Class X SMA/MA Physics students. The research method uses research and development (R&D) using the Plomp model which includes three stages, namely: preliminary research, prototype development phase, and assessment phase. The instruments used in this research are validity questionnaire, practicality questionnaire, and observation sheet. The results showed that the Discovery Learning-based E-Module was valid, and practical towards the critical thinking skills of SMA/MA Class X Physics students. The validity of the e-module has an average of 90.3% in terms of material, construction and language with a very valid category. The practicality of the e-module has an average value of 92.5% with a very practical category. Meanwhile, the level of implementation of Discovery Learning in learning is in the "mostly implemented" category and the percentages of agreement for session I are in the Good Agreement criteria. So, the e-module developed is valid and practical, so it can be used as teaching material in the learning process.

Keywords: E-module, Discovery Learning, Critical Thinking

INTRODUCTION

The demand for learning in the 21st century is to produce human resources who have 4C skills, namely critical thinking, collaboration, communication, and creativity (Roza et al., 2022). Critical thinking skills have an important role in helping students master the material of each lesson as well as its application in everyday life and can be used to solve problems and as a consideration in making correct decisions (Agnes Aktapianti Br. Ginting et al., 2022).

However, the reality in the field shows that the critical thinking skills of Indonesian students are still relatively low. According to research conducted by (Sidabutar et al., 2022) mentioned that the critical thinking skills of students are still low, as seen from the fact that the activities of

students in the learning process tend to be more dominant passive in answering a question. Furthermore, research (Gunawan & Putra, 2019) in his research states that students are only able to solve the same problems as the existing example problems and the learning model in the learning process has not been varied.

Many factors contribute to the low critical thinking skills of these students. The first factor is that teaching materials in the form of printed books tend to burden students because the price of books continues to increase every year. Printed books are also less attractive to educators and students. The second factor is that students are less trained to solve problems with characteristics such as questions whose contextual substance requires reasoning, argumentation, and resolution (Yampap & Bay, 2020). In addition, the cause of low critical thinking skills can be seen in the characteristics of Generation Z, which tends to be interested in practical things and is very dependent on technology (Sa'adah et al., 2022). Based on the two factors above, it can be seen that there is indeed a mismatch between the teaching materials that educators use and the characteristics of Generation Z students who are more interested in teaching materials that are interesting, practical and dependent on technology. The low critical thinking skills of students will have an impact on learning outcomes, because there is a correlation between critical thinking skills and learning outcomes (Simamora et al., 2021).

There have been many studies conducted to overcome the problem of students' critical thinking skills, by developing teaching materials in the form of e-modules. Such as research conducted by (Siburian et al., 2022) with the title "Development of E-Modules on Dynamic Fluid Material aided by Flip PDF Professional to Train Critical Thinking Skills of Class XI High School Students". Based on the results of the study, it can be concluded that the results of expert validation consisting of 3 expert judgments on the e-modules developed, they are included in the very feasible category and based on the product readability test conducted by 3 validators (teachers) on the e-modules developed are included in the very feasible category. Then the research was conducted by (Apriyani et al., 2020) with the title "Development of Physics Modules based on Discovery Learning on Static Fluid Material for Class XI Students of SMA Negeri 1 Lubuk Linggau 2019/2020 School Year". Based on his research, it can be concluded that the discovery learning-based physics module on static fluid material can be said to be valid, practical, and effective.

Based on the description above, an alternative solution to overcome this problem that researchers will develop is to develop a product in the form

of an e-module. Researchers have an innovation, namely an independent learning curriculum e-module on renewable energy material in class X. Then the researcher applies a learning model in the e-module, namely the discovery learning model, and there are practicum activities in the e-module with the help of the PhET simulation application. So the researchers conducted development research with the title "Development of Discovery Learning-Based E-Modules for Critical Thinking Skills of Physics Learners in Class X SMA / MA". The objectives of this research are: (1). Develop e-modules based on discovery learning on the critical thinking skills of physics students in class X SMA / MA. (2). Knowing the validity and practicality of e-modules based on discovery learning on the critical thinking skills of physics students in class X SMA / MA.

METHODS

The research method used is the Research and Development (R&D) method using the Plomp model, which includes three stages of development: Preliminary research, development of prototype phase, and assessment phase.

1. Preliminary research

At this stage, a needs analysis (educators and students), and a literature analysis are carried out. The needs analysis stage aims to find out what needs are needed to overcome the problems found in learning activities so that teaching material development is needed. With this analysis, a description of the facts, expectations, and alternative basic problem solving will be obtained which makes it easier to determine or select the teaching materials developed. Literature analysis is carried out by analyzing theories and concepts related to research. Literature analysis is related to the discovery learning model, and the results that have been applied in schools, and theories that support the development of e-modules based on discovery learning.

2. Development of prototype phase

This stage is a continuation of the first stage, aiming to produce a prototype of e-module development based on discovery learning on the critical thinking skills of physics students in Class X SMA/MA that is valid. The activity stages are designing prototypes, conducting formative evaluations and revising prototypes. At this stage of the design, grids also made for validation assessment instruments, and the practicality of e-modules based on discovery learning affects the critical thinking skills of physics students in Class X SMA / MA. Data collection instruments at this stage can be seen in table 1:

Table 1. Data collection instruments

Data	Instruments
Validity Test	Product validation questionnaire to assess e-modules based on discovery learning on critical thinking skills of physics students in class X SMA / MA

The validity questionnaire was given to 3 validators (1 material/content validator, 1 media validator and 1 language validator).

After qualitative and quantitative data were obtained, data processing was carried out. The collected data were analyzed using the Likert scale technique with positive categories, where positive statements received the highest weight as shown in Table 2:

Table 2. Statement Weight

No	Statement	Weight
1	Strongly disagree	1
2	disagree	2
3	Simply	3
4	Agree	4
5	Strongly agree	5

(Source : Sugiyono, 2013)

The final score that has been validated is analyzed on a scale (1-100) obtained using the formula:

$$P = \frac{x}{y} \times 100\% \dots \dots \dots (1)$$

Where P is the percentage of the score obtained, X is the score received and Y is the maximum score. The final value referred to the interval for determining validity is shown in table 3.

Table 3. Criteria for Level of Validity

No	Interval	Category
1	0 - 20	Very invalid
2	21 - 40	Invalid
3	41 - 60	Valid enough
4	61 - 80	Valid
5	81 - 100	Very valid

(Source : Modified from Riduwan, 2010)

3. Assesment Phase

The purpose of this stage is to see the practicality of the prototype 2 e-module resulting from the development phase. The level of practicality is seen from the answers to the practicality questionnaire by 1 physics educator and the practicality questionnaire by students. The implementation of e-modules in the learning process is seen based on observation sheets by two observers. Data collection instruments at this stage can be seen in table 4:

Table 4. Data Collection Instruments

Data	Instruments
Practicality Test	1. e-module practicality questionnaire by educators and students 2. Observation sheet for the implementation of the Discovery Learning Model in learning

The practicality questionnaire was filled in by 1 educator and 20 students. The observation sheet was filled in by 2 observers to see the implementation of the discovery learning model in the learning process. After qualitative and quantitative data were obtained, data processing was carried out. The collected data were analyzed using Likert scale technique with positive categories, i.e. positive statements get the highest weight as shown in Table 5:

Table 5. Statement Weights

No	Statement	Weight
1	Strongly disagree	1
2	disagree	2
3	Simply	3
4	Agree	4
5	Strongly agree	5

(Source : Sugiyono, 2013)

The final score that has been validated is analyzed on a scale (1-100) obtained using the formula:

$$P = \frac{x}{Y} \times 100\% \dots \dots \dots (1)$$

Where P is the percentage of the score obtained, X is the score received and Y is the maximum score. The final score referred to the practicality determination interval is shown in table 6:

Table 6. Criteria for Practicality Level

No	Interval	Category
1	0 - 20	Very impractical
2	21 - 40	Not practical
3	41 - 60	Practical enough
4	61 - 80	Practical
5	81 - 100	Very practical

(Source : Modified from Riduwan, 2010)

The technique of analyzing the implementation of the discovery learning model in the learning process is: the results of the assessment of the two observers determined the average value of T (Implemented). T1 is the average value of the first observer and T2 the average value of the second observer. This T value is then confirmed with the interval of determining the

category of the implementation of discovery learning in the learning process, see table 7:

Table 7. Criteria for the implementation of the discovery learning model in the learning process

Criteria	Implementation Level	Category
All done	>3.20	Very practical
Mostly accomplished	2.40 – 3.20	Practical
Half of it done	1.61 – 2.40	Practical enough
Only a small part is done	0.81 – 1.60	Less Practical
Nothing has been done	<0.80	Not Practical

(Source : Sari, 2018)

To determine the level of consistency and stability between two observers in observing the implementation of Discovery Learning from the

meeting, percentages of agreements were used (Sari, 2018). The level of percentages of agreements between the two observers for each meeting used the formula proposed by Grinnell as follows:

$$\text{percentages of agreements} = \frac{\text{Agreements (A)}}{\text{Disagreements (D)} + \text{Agreements (A)}} \times 100\%$$

Where *Agreements (A)* is the frequency of matches between two observers, *Disagreements (D)* is the frequency of mismatches between the data of two observers and P is the coefficient (degree) of instrument reliability. Details of the criteria for the level of percentages of agreements based on Altman's provisions. In table 8:

Table 8. Criteria for Determining percentages of agreements

Value	%	Criteria
<0.2	<20	Poor Agreement
0.21 – 0.40	21-40	Fair Agreement
0.41 – 0.60	41 - 60	Moderate Agreement
0.61 – 0.80	61 - 80	Good Agreement
0.81 – 1.00	81 - 100	Very good Agreement

(Source: Sari, 2018)

So to state that the Discovery Learning Model developed is practical if it meets the two predetermined criteria.

RESULTS AND DISCUSSION

Based on the objectives and research procedures, namely to develop discovery learning-based e-modules on the critical thinking skills of physics students that are valid, and practical. Plomp Development Model which consists of 3 stages, namely:

1. Preliminary research

In the preliminary stage, a needs analysis (educators and learners) and literature analysis were conducted.

a. Needs analysis (educators and learners)

Based on the results of interviews with physics educators and students at SMAN 10 Bungo, it can be concluded that students find it difficult to understand lessons so they need interesting teaching materials such as electronic teaching materials that can make it easier for students to understand learning materials.

b. Literature analysis

Literature analysis to find concepts or theoretical foundations that strengthen discovery learning-based e-modules on the critical thinking skills of physics students in class X SMA/MA developed. In this stage, the results of the analysis are summarized in Table 9:

Table 9. Literature Analysis/Literature Studies

Aspects	Supporting theory	Reference
Development stage	Preliminary research prototyping phase assesment phase	Plomp in Sari (2018)
Critical thinking	Critical thinking	Cahyanto & Lesmono (2022) Agnes aktapianti, dkk (2022) Arini&Juliadi (2018) Nurlaili (2021) Tumanggor (2021)
	Indicators of Critical thinking	Maulana (2017)
Discovery learning	Discovery learning	Khasinah (2021) Susana (2019)
E-modules	E-Modules	Herawati&Muhtadi (2018) Sidik&Kartika (2020) Sukiman (2012) Laili(2019)
Physics Materials	Renewable energy	Ayuk Ratna, ddk (2021) Fitriyani (2022)

2. Development of prototype phase

The development or prototype stage aims to produce a valid discovery learning-based e-module prototype. The stages of the development of prototypes are as follows:

a. Designing Prototypes

In the prototype design stage, the design of the e-module and the design of research instruments are carried out. After the initial design stage of e-modules based on discovery learning, the next step is the development of e-modules. The results of e-module development can be seen in Figure 1:

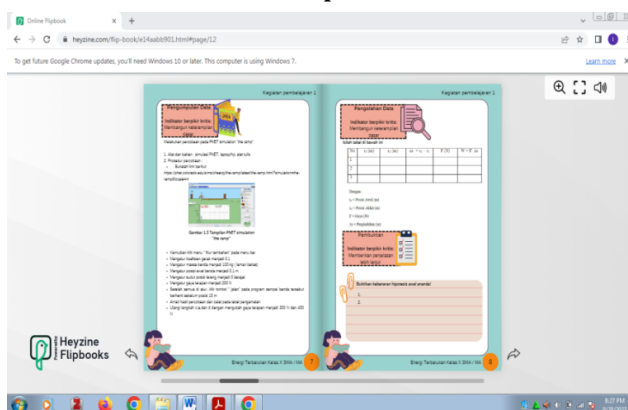


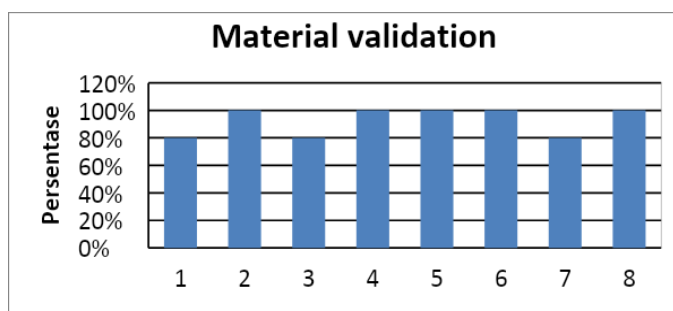
Figure 1. e-modules display

b. Formative Evaluation

The purpose of this stage is to produce e-modules based on discovery learning on the critical thinking skills of physics participants in class X SMA / MA that are valid. The validity test data was obtained from filling out a material validation questionnaire, language questionnaire and media questionnaire. The questionnaire was filled in by 1 material expert, 1 language expert and 1 media expert. The following is presented the trial data:

1) Material/Content Validation Test

The content validity test indicator of the e-module teaching material consists of 8 statements. The lowest score of each statement is 1 and the highest score is 5. The data from the content validity test can be seen in graph 1:



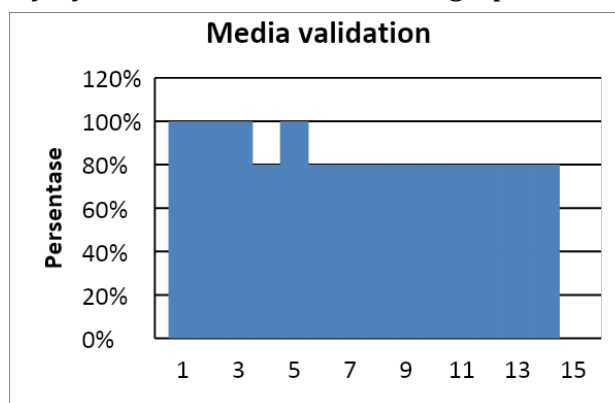
Graph 1. Data from Material Validity Test Results

Graph 1 shows the average value of material validation results from 1 validator. The results obtained from the AA validator were 93%, with a very

valid category. The product can be used as teaching material in the learning process and can be continued to the product practicality test stage.

2) Media Validity Test

The media validity indicator consists of 14 statements. The value for construction validity by 1 validator can be seen in graph 2:

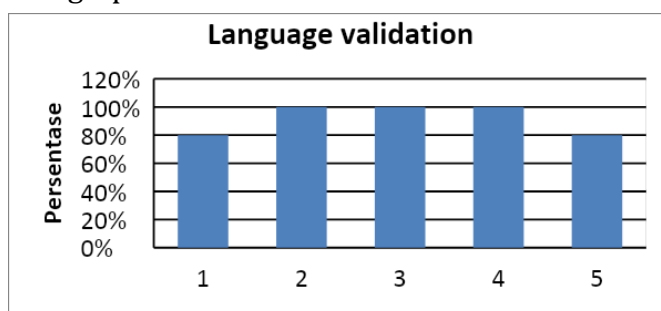


Graph 2. Data from media validity test results

Graph 2 shows the average results of media validity by media validators. The results of the media validity assessment with an average of 86%, the product can be used as teaching material and can be continued to the product's practicality test stage. suggestions given by validators are used as guidelines for improving e-modules.

3) Language Validity Test

The content validity test was given to 1 validator using a questionnaire consisting of 5 statements. The lowest score for each content validation statement is 1 and the highest score is 5. The data from the language validity test can be seen in graph 3:



Graph 3. Data from Language Validity Test Results

Average results of language validity by language validators. The results of the language validity assessment with an average of 92%. The product can be used as teaching material and can be continued to the product practicality test stage. Suggestions given by validators are used as guidelines for improving e-modules. The assessment given by the three product validators with 3 categories of assessment, namely the assessment of material/content

validity, media validity and language validity. The average value of discovery learning-based e-module validity can be seen in table 10:

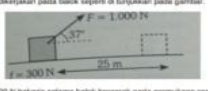
Table 10 Average Validator Score for each Indicator

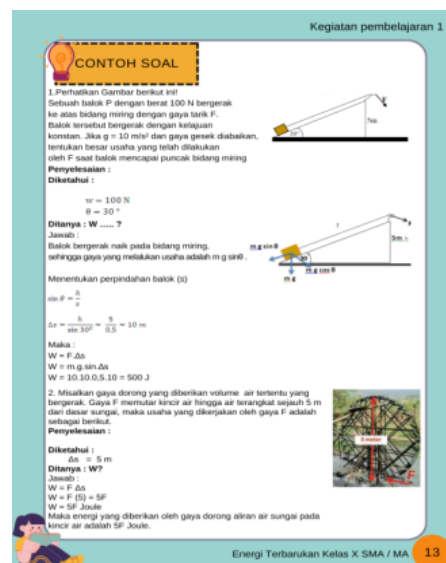
Indicator	Percentage	Category
Language Feasibility	92%	Very Valid
Appropriateness of material / content	93%	Very Valid
Media Feasibility	86%	Very Valid
Average Percentage	90,3%	Very Valid

c. Prototype Revision

At this stage, a prototype II e-module based on discovery learning was produced for critical thinking skills of physics students in class X SMA/MA. However, there are several product revisions obtained from construction validators. Suggestions from validators can be seen in table 11:

Table 11. Product Revision Results

Before Revision	After Revision
Kegiatan pembelajaran 1 AYO BERLATIH 3. Dua mobil sedan yang sedang melaju tiba-tiba berhenti di tengah jalan. Setelah dilakukan pengukuran oleh pengemudi ternyata mobil tersebut mogok. Tidak lama kemudian, disusullah petugas lalu lintas dengan menawarkan jasa derek mobil. Kedua mobil tersebut derek dengan posisi yang berbeda. Mobil A diderek dengan posisi dasar dan mobil B diderek dengan posisi bagian depan mobil diangkat dengan sudut 45°. Kedua mobil tersebut diketahui memiliki massa 100 dan perpindahan yang dilakukan mobil derek tersebut sejauh 50m. Menurut kalian, posisi manakah yang lebih efektif saat menderek sebuah mobil? Agar usaha pada mobil derek tidak terlalu besar? A. Posisi dasar, karena lebih besar usahanya B. Posisi miring, karena lebih besar usahanya C. Posisi dasar, karena lebih kecil usahanya D. Posisi miring, karena lebih kecil usahanya E. Kedua posisi sama besar 4. Gaya 1.000 N dikerjakan pada balok seperti di tunjukkan pada gambar.  Gaya gesekan 300 N bekerja selama balok bergerak pada permukaan sepanjang 25 m. Besar usaha yang dilakukan oleh gaya yang dikerjakan untuk menggerakkan balok ini adalah... A. 1000 J B. 1800 J C. 2000 J D. 2700 J E. 3000 J Energi Terbarukan Kelas X SMA / MA 15	Kegiatan pembelajaran 1 AYO BERLATIH 3. Dua mobil sedan yang sedang melaju tiba-tiba berhenti di tengah jalan. Setelah dilakukan pengukuran oleh pengemudi ternyata mobil tersebut mogok. Tidak lama kemudian, disusullah petugas lalu lintas dengan menawarkan jasa derek mobil. Kedua mobil tersebut derek dengan posisi yang berbeda. Mobil A diderek dengan posisi dasar dan mobil B diderek dengan posisi bagian depan mobil diangkat dengan sudut 45°. Kedua mobil tersebut diketahui memiliki massa 100 dan perpindahan yang dilakukan mobil derek tersebut sejauh 50m. Menurut kalian, posisi manakah yang lebih efektif saat menderek sebuah mobil? Agar usaha pada mobil derek tidak terlalu besar? A. Posisi dasar, karena lebih besar usahanya B. Posisi miring, karena lebih besar usahanya C. Posisi dasar, karena lebih kecil usahanya D. Posisi miring, karena lebih kecil usahanya E. Kedua posisi sama besar 4. Gaya 1.000 N dikerjakan pada balok seperti di tunjukkan pada gambar.  Gaya gesekan 300 N bekerja selama balok bergerak pada permukaan sepanjang 25 m. Besar usaha yang dilakukan oleh gaya yang dikerjakan untuk menggerakkan balok ini adalah... A. 1000 J B. 1800 J C. 2000 J D. 2700 J E. 3000 J Energi Terbarukan Kelas X SMA / MA 15
Kegiatan pembelajaran 1 Seberapa lama waktu yang digunakan untuk melakukan usaha dinyatakan dengan besaran daya. Secara matematis, daya dinyatakan dengan persamaan matematis berikut ini: $P = \frac{W}{t}$ Dengan: P = daya (Watt) W = usaha (Joule) t = waktu (s) Dalam kehidupan sehari-hari, energi tidak selalu dinyatakan dalam satuan SI, Joule. Satuan energi, kalornya dengan daya, bisa dinyatakan dalam kilowatt jam (kWh). $1 \text{ kWh} = 1.000 \text{ W} \times 60 \text{ menit}$ $1 \text{ kWh} = 1.000 \text{ W} \times 3.600 \text{ s}$ $1 \text{ kWh} = 3.6 \times 10^6 \text{ J}$ Man mencoba aplikasi persamaan tersebut pada kincir air tersebut dengan contoh kasus berikut.  Misalkan gaya dorong yang diberikan volume air tertentu yang bergerak. Gaya F memutar kincir air hingga air bergerak sejauh 5 m dari dasar sungai, maka usaha yang dikerjakan oleh gaya F adalah sebagai berikut. $W = F \cdot s$ $W = F (5) = 5F$ $W = 5F \text{ Joule}$ Maka energi yang diberikan oleh gaya dorong akan air sungai pada kincir air adalah 5F Joule. Energi Terbarukan Kelas X SMA / MA 12	Kegiatan pembelajaran 1 Seberapa lama waktu yang digunakan untuk melakukan usaha dinyatakan dengan besaran daya. Secara matematis, daya dinyatakan dengan persamaan matematis berikut ini: $P = \frac{W}{t} \quad \text{Pers (1.3)}$ Dengan: P = daya (Watt) W = usaha (Joule) t = waktu (s) Dalam kehidupan sehari-hari, energi tidak selalu dinyatakan dalam satuan SI, Joule. Satuan energi, kalornya dengan daya, bisa dinyatakan dalam kilowatt jam (kWh). $1 \text{ kWh} = 1.000 \text{ W} \times 60 \text{ menit}$ $1 \text{ kWh} = 1.000 \text{ W} \times 3.600 \text{ s}$ $1 \text{ kWh} = 3.6 \times 10^6 \text{ J}$ Energi Terbarukan Kelas X SMA / MA 12

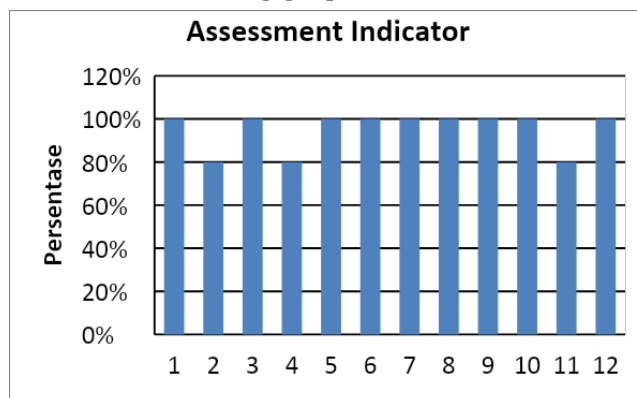


3. Assesment Phase

The purpose of this stage is to see the practicality and implementation of discovery learning in the learning process of the prototype II e-module based on discovery learning development results. The level of practicality is seen from the answers to the practicality questionnaire by 1 physics educator and the practicality questionnaire by 20 students of SMAN 10 Bungo. The implementation of discovery learning in the learning process is seen from the observations of 2 observers.

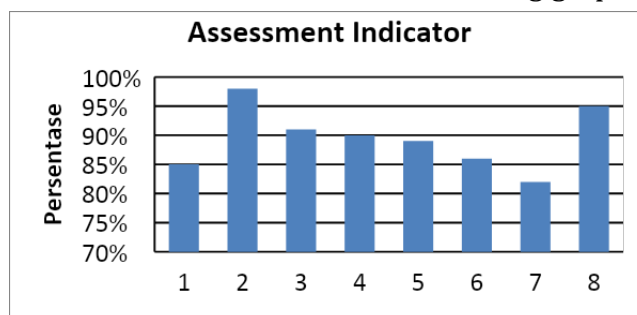
a. Practicality Test

Practicality test was obtained from distributing questionnaires to physics educators at SMAN 10 Bungo and 20 class X students at SMAN 10 Bungo. Indicator statements for the practicality test by educators were 12 statements and students were 8 statements. The data obtained from the results of the practicality of e-modules based on discovery learning by educators can be seen in the following graph 4:



Graph 4. Data on Practicality Test Results by Physics Educators

Graph 4 above shows that the value of the practicality questionnaire results by 1 physics educator obtained an average result of 95% with a very practical category. The product can already be continued to the product effectiveness stage. The product practicality test by students was given to 20 students of class X SMAN 10 Bungo. The results of the analysis of product practicality by students can be seen from the following graph 5:



Graph 5. Data from Practicality Test Results by Students

Graph 5 states that the value of the results of the students' practicality questionnaire filled in by 20 class X students obtained a result of 90% with a practical category. The product can already be used as a learning media. Practicality is the ease that exists in a product both in preparing, using, and the ease of storing it.

b. Test the applicability of the discovery learning model

The implementation of discovery learning in learning was observed by two observers using an observation sheet. Observations were made by observers who focused on aspects of the implementation of learning syntax accompanied by the application of social principles by educators during the learning process. The complete results of the observation of the implementation of discovery learning are in table 12:

Table 12. Summary of Practicality Test Results of discovery learning

No	Aspects	Phase	Test Run		Average	Category
			Pendidik	Pesdik		
1	Observation of the implementation of discovery learning	Sesi I	3,86	3,83	3,84	Very Practical
		Percentages of agreements	75	71	73%	Good Agreement
2	Practicality of e-modules				92,5%	Very Practical

Based on the data in Table 12, it shows that the discovery learning developed is very practical because it has fulfilled two predetermined criteria. The results of the assessment of educators and students stated that the e-module discovery learning is categorized as very practical. The level of implementation is in the "mostly implemented" category and the percentages of agreement for session I are in the Good Agreement criteria.

The results of validation and trials that have been carried out on discovery learning based e-module that have been developed are valid and practical, so that e-module can be used by educators and students as teaching materials in class X on renewable energy material. This research is in line with the results of research from Okta Alpindo, et al entitled "Development of Discovery Learning-Based Interactive Physics Teaching Materials to Improve Students' Critical Thinking Skills". interactive physics teaching materials in the discovery learning model to improve students' critical thinking skills are declared valid, practical and effective. (Alpindo et al., 2022). And research conducted by Nurul Latifah, et al, the development of physics e-modules to improve students' critical thinking obtained a score with a fairly good category and the average reliability of all validators with a very reliable

category, so that the e-module is feasible to use in learning (Latifah et al., 2020).

CONCLUSIONS

The development of e-modules based on discovery learning on critical thinking skills of physics participants in class X SMA / MA is feasible to use from several aspects of assessment including, validity of e-modules based on discovery learning in terms of language, material / content and construction with an average score of 90.3% with a percentage of language feasibility test with a score of 92%, percentage of material / content feasibility test with a score of 93% and percentage of construction feasibility with a score of 86%. The product practicality test obtained an average score of 92.5%. By 1 educator getting an average of 95% and 20 students averaging 90%. And the level of implementation of discovery learning-based e-modules is in the "mostly implemented" category and percentages of agreement for session I are in the Good Agreement criteria. So, the e-module that has been developed is feasible and can be used as teaching material in the learning process at school. Suggestions for further researchers can develop e-modules that can fill in answers directly on a cellphone or laptop, no need for other materials such as answer paper. Further researchers to be able to develop e-modules until the effectiveness test stage.

REFERENCES

- Agnes Aktapianti Br. Ginting, Darmaji, D., & Dwi Agus Kurniawan. (2022). Analisis Pentingnya Keterampilan Proses Sains terhadap Kemampuan Berpikir Kritis di SMA Se-Kecamatan Pemayung. *Jurnal Pendidikan Mipa*, 12(1), 91–96.
- Alpindo, O., Liana, M., & Fitriani, R. (2022). Pengembangan Bahan ajar Fisika Interaktif Berbasis Discovery Learning Untuk Meningkatkan Critical Thinking Skill Peserta Didik. *Jurnal Pendidikan Fisika*, 10(1), 35–48.
- Apriyani, N., Ariani, T., & Arini, W. (2020). Pengembangan Modul Fisika berbasis Discovery Learning Pada Materi Fluida Statis Siswa Kelas XI SMA Negeri 1 Lubuk Linggau Tahun Pelajaran 2019/2020. 2(1).
- Gunawan, R. G., & Putra, A. (2019). Pengaruh strategi belajar aktif sortir kartu terhadap kemampuan pemecahan masalah matematis. *Jurnal Pendidikan Matematika*, 03(02), 362–370.
- Latifah, N., Ashari, & Kurniawan, E. S. (2020). Pengembangan e-modul fisika untuk meningkatkan kemampuan berpikir kritis peserta didik. *Jurnal Inovasi Pendidikan Sains*, 01(01), 1–7. <http://jurnal.umpwr.ac.id/index.php/jips/article/view/570>
- Riduwan. (2010). *Metode dan Teknik Menyusun Tesis* (Akdon & Z. Arifin (eds.); Ke-8). Alfabeta.

- Roza, M., Lufri, L., Andromeda, A., & Mufit, F. (2022). Science Teacher's Perception of Digital Technology-Based Learning in the 21st Century. *Jurnal Pendidikan Progresif*, 12(1), 281–293. <https://doi.org/10.23960/jpp.v12.i1.202222>
- Sa'adah, A. N., Rosma, A., & Aulia, D. (2022). Persepsi Generasi Z Terhadap Fitur Tiktok Shop Pada Aplikasi Tiktok. *Akutansi, Bisnis Dan Keuangan*, 2(5), 131–140.
- Sari, M. (2018). *Pengembangan Model Blended Learning dengan Facebook (MBL-FB) Pada Perkuliahan Biologi Umum Di LPTK-PTKI*. Universitas Negeri Padang.
- Siburian, V. F., Putri, D. H., & Medriati, R. (2022). Pengembangan E-Modul Materi Fluida Dinamis Berbantuan Flip PDF Profesional Untuk Melatihkan Kemampuan Berpikir Kritis Siswa SMA. *Jurnal Ilmu Pembelajaran Fisika*, 1(2).
- Sidabutar, F. R., Hasan, A. M., & Nusantara, E. (2022). Validitas Perangkat Praktikum Virtual Terintegrasi Model Pembelajaran Discovery Learning Untuk Meningkatkan Kemampuan Berpikir Kritis Siswa. *Jambura Edu Biosfer Journal*, 4(1), 37–43.
- Simamora, R., Kurniawan, D. A., & Munte, B. (2021). Upaya Peningkatan Kemampuan Berpikir Kritis Siswa Menggunakan Simulasi Virtual Pada Materi Momentum Dan Impuls di SMAN 1 Siempat Nempu Hilir. *Jurnal Usahidsolo*, 1(1), 37–45.
- Sugiyono. (2013). *Metode Penelitian Kuantitatif Kualitatif dan R&D* (cetakan 19). Alfabeta.
- Yampap, U., & Bay, H. R. (2020). Penerapan Pendekatan Keterampilan Proses Untuk Meningkatkan Keterampilan Berpikir Kritis Siswa Sekolah Dasar. *Journal of Primary Education*, 3(1), 57–64. <https://doi.org/10.35724/musjpe.v3i1.3201>