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RESEARCH ARTICLE

Pengembangan E-Modul Minyak Bumi Berbasis *Guided Discovery Learning* untuk Kelas XI SMA/MA

Development of Petroleum E-Module Based on Guided Discovery Learning for Class XI Senior High School

M Jannah[1*], and Suryelita[1]

[1] Chemistry Education, Padang State University, Jl. Prof. Dr. Hamka, Air Tawar Barat, North Padang, West Sumatra, Indonesia. 25171.

* miftahuljannah281198@gmail.com

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ABSTRACT

Petroleum material studied at class XI senior high school. This material is considered by the teacher to be studied independently by giving reading assignments and exercises. The teaching materials used are a summary of the material and don't contain images, videos, audio, or questions, and aren't scientifically derived. Needed are teaching materials per the curriculum and technological advances, which are one through e-modules. This study aimed to develop a petroleum e-module based on gdl for class xi high school and determine its validity and practicality. The research type is design research with plomp's model. This method consists of three stages of preliminary research, prototyping phase, and assessment phase. This study was limited to small groups at the prototype stage iii. The validity test was carried out by five validators. The practicality test was carried out by two chemistry teachers and twelve students. The data collection instruments were validity questionnaires and practicality questionnaires. The results of the validity questionnaire were analysed by the aiken's v formula and the practical results using descriptive statistical formula. The results of the study show that the content validity of the e-module based on gdl- is valid (0.88), Then the construct validity was in the valid category (0.89). The practicality of teachers is in the practical category (79.86%), And students are in the very practical category (84.91%). Further research is needed, namely field tests to determine practicality and effectiveness on a broad scale.

KEYWORDS

E-Module, Guided Discovery Learning, Petroleum, Plomp Model

ABSTRAK

Materi minyak bumi dipelajari di kelas 11 SMA. Materi ini dianggap guru bisa dipelajari secara mandiri dengan memberikan tugas baca dan latihan. Bahan ajar yang digunakan yaitu ringkasan materi yang hanya ada 1 gambar, belum ada video, audio, pertanyaan, dan belum saintifik. Diperlukan bahan ajar sesuai dengan kurikulum dan kemajuan teknologi, salah satunya e-modul. Penelitian ini bertujuan untuk mengembangkan e-modul minyak bumi berbasis GDL untuk SMA/MA XI dan menentukan validitas dan kepraktisan. Jenis penelitian ini adalah design research dengan menggunakan model Plomp. Metode ini terdiri tiga tahapan preliminary research, prototyping phase dan assessment phase. Penelitian ini dibatasi sampai small group pada tahap prototipe III. Uji validitas dilakukan oleh lima orang validator. Uji kepraktisan dilakukan oleh dua guru kimia dan 12 siswa. Instrumen pengumpulan data berupa angket validitas dan angket kepraktisan. Hasil angket validitas dianalisis dengan rumus Aiken's v dan hasil praktikalitas menggunakan rumus statistik deskriptif. Hasil penelitian menunjukkan validitas konten e-modul berbasis GDL valid (0,88), kemudian validitas konstruk dengan kategori valid (0,89). Praktikalitas guru dengan kategori praktis (79,86%), praktikalitas siswa kategori sangat praktis (84,91%). Diperlukan penelitian lanjutan yaitu field test untuk mengetahui praktikalitas dan efektifitas dalam skala luas.

KATA KUNCI

E-modul, Guided Discovery Learning, Minyak bumi, Model Plomp

1. INTRODUCTION

Petroleum is studied in class XI senior high school in the odd semester. This material is considered by the teacher to be studied by students independently by giving reading assignments and exercises. The teaching material used is a summary of the material which is only one picture, does not have videos, audio, and questions. The learning process has not been scientific. Scientific learning requires students to observe, reason, explain and communicate. To help students increase their interest in learning so that it is easier to understand the material, needed are teaching materials interactive and technology-based, one of which is e-modules[1].

The development of technology makes learning more interactive, efficient, and effective[2]. Technology-based learning provides positive value for both teachers and students in learning activities such as the ease of accessing material-related information[3]. Utilizing technology provides opportunities for teachers to present teaching materials to make them more attractive, one of which is an electronic module (e-module)[4].

E-module is a presentation of self-learning materials that are systematically arranged to achieve learning objectives that are presented in an electronic format[5]. E-modules can be packaged attractively with pictures, animations, audio, videos related to learning materials, and interactive questions[6]. The use of e-modules effectively increases students' understanding of concepts in mastering chemistry material[7].

The success of students in understanding the material can be achieved by using a scientific approach[8]. The application of a scientific approach can be developed through learning models. One of the learning models that can be applied to petroleum e-modules and following a scientific approach is guided discovery learning (GDL). The preparation of the e-module is designed according to the syntax of the GDL learning model referred to by Smitha consisting of five steps, namely:(1) motivation and problem presentation; (2) selection of learning activities; (3) data collection; (4) data processing; (5) closure.

GDL is a concept discovery learning model with guidance from the teacher who is guiding[9]. Students discovering concepts are encouraged and strengthened by the teacher so that they can motivate them in learning activities[10]. GDL-based learning educators act as motivators and mentors for students in learning activities[11].

Based on the observation results, it was found that students used simple teaching materials, namely in the form of a summary of petroleum material. It only contains one picture with less attractive color and there are no teacher and student instructions. Then there are no questions that can direct and guide students in discovering new concepts. The results of the questionnaire analysis given to 30 people showed that 53% of students did not understand petroleum material using the available teaching materials.

Then another alternative is needed to facilitate students in learning activities, one of which is the e-module. E-modules are not only focused on writing but can contain images, animations, audio, videos related to material, and quizzes as well as other features that can support learning. The use of e-modules is also supported by the readiness of teachers and students who already have cell phones, laptops, and good network connections.

Relevant research related to the development of e-modules has been carried out by Prayuda which states that the use of e-modules in learning activities can increase students' learning motivation[12]. Then learning using e-modules makes students more interested and not lazy in learning[13]. In addition, this teaching material can facilitate students in learning petroleum material[8]. Based on the background of the problems above, the researcher conducted a study entitled "Development of Petroleum e-Modules Based on Guided Discovery Learning for Class XI senior high school".

2. METHOD

This research was conducted on the campuses at the Faculty of mathematics and science, State University of Padang, and Senior High School 1 Payakumbuh district. The research subjects were three chemistry lecturers at the State University of Padang, two chemistry teachers, and twelve students from class XI science senior high school 1 Payakumbuh district.

The type of research used is educational design research with the Plomp development model. This model consists of three stages, namely preliminary research, prototype formation stage (prototyping phase), and assessment phase[14]. This research is only up to a small group. According to the Plomp stage, it was tested in small groups first, then in field tests. Because the students had studied petroleum material, they could not do a field test which had to be adjusted to the school's study schedule.

In the preliminary research stage, the activities are (1) needs analysis, namely analyzing and gathering information, defining problems, and planning the continuation of research; (2) context analysis, namely by analyzing basic competencies to formulate learning objectives to be achieved according to the demands of the 2013 curriculum; (3) literature study to collect various sources, be it books, journals, articles, or references from the internet relating to problem-solving in research activities to be carried out; and (4) development of the conceptual framework that forms the basis for product formation.

The prototype development stage (prototyping phase) is carried out by designing the initial framework of the e-module. This stage is carried out by designing the e-module according to its components and the syntaxes of the GDL.

Then in the prototype stage, a self-evaluation was carried out on the initial product to see deficiencies in the development of the e-module. Further revisions are carried out to produce a complete e-module.

In Prototype II the complete e-module is reflected by expert review (expert judgment) and one-to-one evaluation (one-to-one evaluation). Expert review is carried out by filling out a validity questionnaire by five validators. A one-to-one evaluation was carried out by three students by filling out interview sheets. Based on the results of the validation, a revision was made to produce a valid GDL-based petroleum e-module.

A valid GDL-based petroleum e-module is carried out formative evaluation through a small group test on prototype III. The evaluation was carried out to get the practical value of the e-module in small groups. After the small group test, improvements will be made if necessary, so that the e-module is practical. E-modules that have been evaluated at the small group stage will then be assessed at the semi-summative evaluation stage through the assessment phase.

The instruments used are validity and practicality questionnaires. Items were assessed for validity, namely content validity and construct validity using Aiken's V index. Content validity relates to state-of-the-art knowledge, which is based on adequate theory. The state-of-the-art in this research is e-module guided discovery learning and petroleum materials. Meanwhile, construct validity relates to the relationship between one component and another. In practicality, there are three aspects, namely ease of use, time efficiency, and benefits.

The data obtained from the validity results were processed using Aiken's V formula shown in the formula below.

$$V = \frac{\sum s}{n(c-1)}$$

The range of the V index is 0 to 1. The validity of the V index obtained from the calculation results can be accepted if it meets the minimum value of validity based on the validity coefficient. The Aiken' V index for five validators with four assessment categories has a value of 0.87 and 0.93. Can be seen in the following Aiken's V table in Figure 1. Practicality results from data obtained through a questionnaire filled out by teachers and students will be processed using the following formula:

$$V = \frac{f}{N} X\ 100$$

The product practicality value is determined based on the criteria that can be seen in Table 1.

TABLE 1
Right-Tail Probabilities (p) for Selected Values of the Validity Coefficient (V)

No. of Items (m) or Raters (n)	Number of Rating Categories (c) 2		3		4		5		6		7	
	V	p	V	p	V	p	V	p	V	p	V	p
2							1.00	.040	1.00	.028	1.00	.020
3							1.00	.008	1.00	.005	1.00	.003
3			1.00	.037	1.00	.016	.92	.032	.87	.046	.89	.029
4					1.00	.004	.94	.008	.95	.004	.92	.006
4			1.00	.012	.92	.020	.88	.024	.85	.027	.83	.029
5			1.00	.004	.93	.006	.90	.007	.88	.007	.87	.007
5	1.00	.031	.90	.025	.87	.021	.80	.040	.80	.032	.77	.047
6			.92	.010	.89	.007	.88	.005	.83	.010	.83	.008
6	1.00	.016	.83	.038	.78	.050	.79	.029	.77	.036	.75	.041
7			.93	.004	.86	.007	.82	.010	.83	.006	.81	.008
7	1.00	.008	.86	.016	.76	.045	.75	.041	.74	.038	.74	.036
8	1.00	.004	.88	.007	.83	.007	.81	.008	.80	.007	.79	.007
8	.88	.035	.81	.024	.75	.040	.75	.030	.72	.039	.71	.047
9	1.00	.002	.89	.003	.81	.007	.81	.006	.78	.009	.78	.007
9	.89	.020	.78	.032	.74	.036	.72	.038	.71	.039	.70	.040
10	1.00	.001	.85	.005	.80	.007	.78	.008	.76	.009	.75	.010
10	.90	.001	.75	.040	.73	.032	.70	.047	.70	.039	.68	.048
11	.91	.006	.82	.007	.79	.007	.77	.006	.75	.010	.74	.009
11	.82	.033	.73	.048	.73	.029	.70	.035	.69	.038	.68	.041
12	.92	.003	.79	.010	.78	.006	.75	.009	.73	.010	.74	.008
12	.83	.019	.75	.025	.69	.046	.69	.041	.68	.038	.67	.049
13	.92	.002	.81	.005	.77	.006	.75	.006	.74	.007	.72	.010
13	.77	.046	.73	.030	.69	.041	.67	.048	.68	.037	.67	.041
14	.86	.006	.79	.006	.76	.005	.73	.008	.73	.007	.71	.009
14	.79	.029	.71	.035	.69	.036	.68	.036	.66	.050	.66	.047
15	.87	.004	.77	.008	.73	.010	.73	.006	.72	.007	.71	.008
15	.80	.018	.70	.040	.69	.032	.67	.041	.65	.048	.66	.041
16	.88	.002	.75	.010	.73	.009	.72	.008	.71	.007	.70	.010
16	.75	.038	.69	.046	.67	.047	.66	.046	.65	.046	.65	.046
17	.82	.006	.76	.005	.73	.008	.71	.010	.71	.007	.70	.009
17	.76	.025	.71	.026	.67	.041	.66	.036	.65	.044	.65	.039
18	.83	.004	.75	.006	.72	.007	.71	.007	.70	.007	.69	.010
18	.72	.048	.69	.030	.67	.036	.65	.040	.64	.042	.64	.044
19	.79	.010	.74	.008	.72	.006	.70	.009	.70	.007	.68	.009
19	.74	.032	.68	.033	.65	.050	.64	.044	.64	.040	.63	.048
20	.80	.006	.72	.009	.70	.010	.69	.010	.68	.010	.68	.008
20	.75	.021	.68	.037	.65	.044	.64	.048	.64	.038	.63	.041
21	.81	.004	.74	.005	.70	.010	.69	.008	.68	.010	.68	.009
21	.71	.039	.67	.041	.65	.039	.64	.038	.63	.048	.63	.045
22	.77	.008	.73	.006	.70	.008	.68	.009	.67	.010	.67	.008
22	.73	.026	.66	.044	.65	.035	.64	.041	.63	.046	.62	.049
23	.78	.005	.72	.007	.70	.007	.68	.007	.67	.010	.67	.009
23	.70	.047	.65	.048	.64	.046	.63	.045	.63	.044	.62	.043
24	.79	.003	.71	.008	.69	.006	.68	.008	.67	.010	.66	.010
24	.71	.032	.67	.030	.64	.041	.64	.035	.62	.041	.62	.046
25	.76	.007	.70	.009	.68	.010	.67	.009	.66	.009	.66	.009
25	.72	.022	.66	.033	.64	.037	.63	.038	.62	.039	.61	.049

Figure 1. Aiken's V Table.

Table 1. Practicality Criteria.

Score range (%)	Criteria
0-20	Very impractical
21-40	Not practical
41-60	Practical enough
61-80	Practical
81-100	Very practical

3. RESULT AND DISCUSSION

After conducting the research, the following results were obtained:

3.1. Preliminary Research Stages

The initial stages of development are carried out through 4 stages, namely:

3.1.1. Needs Analysis

From the background of the problem, it is obtained from a needs analysis that: 1) To increase the activity of students in learning petroleum materials, teaching materials are needed which are equipped with pictures, animations, audio, and video to make them more interesting; 2) Students need teaching materials that contain questions to direct them in finding new concepts according to the GDL syntax; 3) A GDL-based petroleum e-module is needed which can increase students' interest in learning.

3.1.2. Context Analysis

Based on the analysis of the syllabus in the 2013 revision of the 2018 curriculum that was carried out, an analysis of basic competencies was obtained which was derived as an indicator of competency achievement. The basic competencies of petroleum materials are as follows.

Explain the process of forming petroleum, its separation techniques, and its uses.

4.2 Presenting works on the formation process and techniques for separating petroleum fractions and their uses.

Identify complete and incomplete combustion reactions of hydrocarbons and the nature of the products of combustion (CO2, CO, carbon particulates).

4.3 Formulate ideas on how to overcome the impact of burning carbon compounds on the environment and health

The basic competencies above are reduced to:

competency achievement indicators (GPA),

that is:

3.2.1 Describe the process of forming petroleum

3.2.3 Describe the technique of separating petroleum fractions based on boiling points

3.2.3 Explain the use of petroleum fractions

3.2.4 Distinguishing the quality of gasoline based on the octane number

4.2.1 Presenting work on the process of forming petroleum

4.2.2 Presenting works on techniques for separating petroleum fractions

4.2.3 Presenting work on the use of petroleum fractions

3.3.1 Identify complete and incomplete combustion reactions of hydrocarbons

3.3.2 Identifying the nature of combustion products (CO2, CO, particulate carbon)

4.3.1 Formulate ideas on how to overcome the impact of burning carbon compounds on the environment and health

3.1.3. Literature Study

In learning activities, teaching materials are needed to help students find concepts. One of the teaching materials that can be used as a learning resource is an electronic module (e-module). According to Aryawan, e-modules are teaching materials designed based on the curriculum and packaged in electronic form[15]. Prastyaningrum in his research "Development of Smartphone e-module by Problem Solving Method for BiotSavart Theory", said that an e-module is an interactive and communicative learning media that makes it easy for students to learn[16]. In addition, e-modules can be accessed via cell phones and laptops, so they can be used anywhere[16].

E-modules are equipped with pictures, videos, audio, and animations to make them more interesting and help students understand the material. This is under Irwansyah's research "Designing Interactive Electronic Modules in Chemistry Lessons", the use of visualization of the content presented in e-modules such as text, video, animation, and audio. aims to make it easy for users to understand the contents of the e-module[17]. The use of e-modules effectively increases students' understanding of concepts in mastering chemical material relevant to Mufida's research "Development of E-modules on Atomic Structure Material can Improve Learning Outcomes"[18].

E-modules can be presented with the guided discovery learning (GDL) syntax referenced from Smitha 2012[19]. This model is one of the suggested learning models in the 2013 curriculum with a scientific approach. Learning in the guided discovery model, the teacher plans a statement or question that guides students, step by step, to make a series of discoveries that lead to a predetermined goal[9]. The application of the GDL model can improve student learning outcomes in petroleum material. Following Mahesa's research "The Effect of Applying the LSLC-Based GDL Model on Student Learning Outcomes at SMA Negeri 15 Padang" the application of the GDL model to electrolysis material affects student learning outcomes[20].

Petroleum material discusses the process of forming petroleum, its separation techniques, petroleum fractions, and their uses in everyday life, and octane numbers and does not require a practicum. The GDL-based petroleum e-module is expected to help students learn this material.

3.1.4. Development of the Conceptual Framework

The development of a conceptual framework is made based on needs and context analysis. The result is to increase the activity of students in studying petroleum material, teaching materials are needed that are by the curriculum and technological advances, one of which is the e-module. Electronic modules (e-modules) are equipped with images, animations, audio, and video to make them more attractive. Making e-modules can use the Flip Pdf Professional application. In designing e-modules, a learning model is needed to assist and direct students in discovering new concepts, one of which is guided discovery learning.

3.2. Development Stage

3.2.1. Preliminary Design

After preliminary research, the initial design of the e-module which contains its components is carried out. The e-module component consists of a cover, table of contents, list of figures, list of tables, introduction (BC, GPA, learning objectives, instructions for using the e-module), activity sheets, worksheets, quizzes, evaluations, answer keys, and bibliography.

The material presented in the e-module is by BC and GPA of oil in two meetings. The e-module is combined with the guided discovery learning model referred to by Smitha.

3.2.2. Prototype I

The initial design of the e-module that has been produced is carried out by self-evaluation using a checklist system for the product components produced. The results of this evaluation need improvement in (1) the addition of the theoretical literature on the formation of petroleum; (2) adjusting GDL syntax with petroleum material; (3) adding cover identity; (4) practice questions adapted to GPA; (5) writing. Evaluation of the self-evaluation resulted in a complete GDL-based petroleum e-module.

3.2.3. Prototype II

In prototype II the complete GDL-based petroleum e-module was reflected by an expert review and filling out validity questionnaires by 2 chemistry lecturers at FMIPA UNP and 3 teachers at SMAN 1 Kec. Payakumbuh. The overall validation results can be seen in Figure 2. The resulting GDL-based petroleum e-module for class XI senior high school has a content validity value of 0.88 and a construct validity of 0.89 with the valid category.

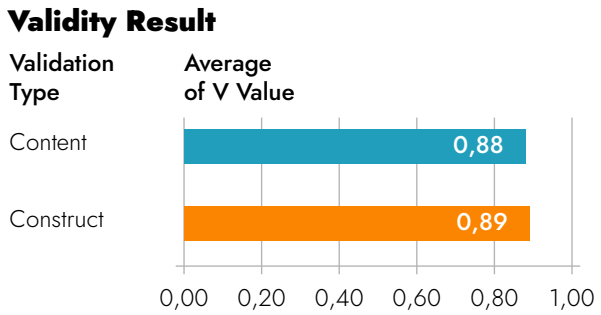

Figure 2. Overall Validity Test Results.

The results of content validation from 5 validators for each activity sheet on petroleum material are presented in Figure 2. The developed material shows that the product is based on the relevant curriculum. The GPA presented in the e-module has been adjusted to BC 3.2, 4.2, 3.3, and 4.3 so that the e-module content on petroleum material can be declared valid. This is following Aiken's table that a product is said to be valid if the value is> 0.87 with five validators and four assessment categories[21]. The validity of the resulting content shows that the GDL-based petroleum e-module product is based on the 2013 revised 2018 curriculum.

The results of the construct validity of the 5 validators for each petroleum material activity sheet are presented in Figure 3. From the diagram in Figure 3, it can be stated that the construct validity of the e-module for each component is valid. This is reinforced by Plomp's 2013 book that every component of research results must be constantly related to one another[14].

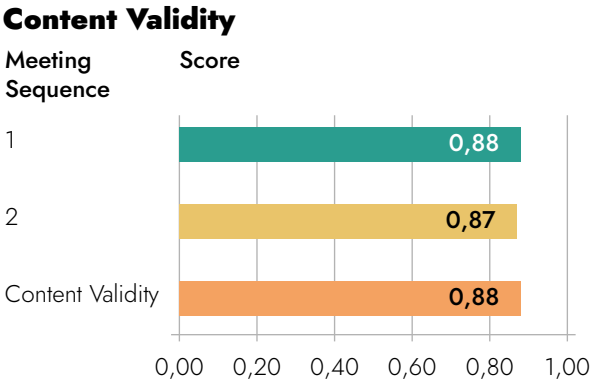

Figure 3. Content Validity Results.

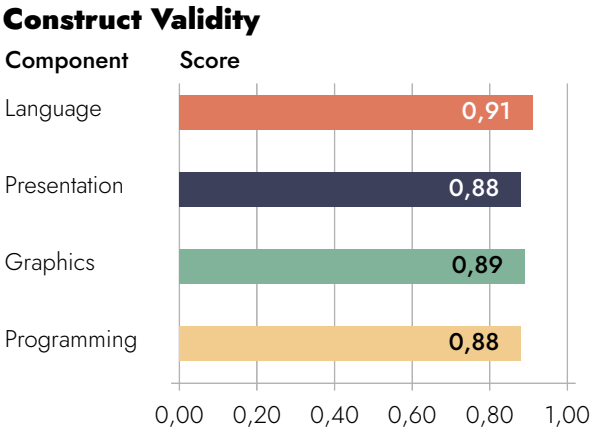

Figure 4. Construct Validity Results.

From Figure 4 the highest rating is in the linguistic component with a value of 0.91 in the valid category. This shows that the developed e-module uses good, simple, and clear Indonesian as per the general writing of Indonesian spelling (PUEBI)[22]. Then the presentation component of the guided discovery learning-based petroleum e-module obtained a value of 0.88 with a valid category. This means that the presentation of the guided discovery learning-based petroleum e-module that has been developed has been systematically arranged based on the components of the e-module by the e-module preparation guidelines. Nurseto said that the presentation of good learning resources is teaching materials that are interesting, easy to see, accurate, and useful[23].

The rating obtained for the programming aspect is 0.88 with a valid category. This shows that the use of features in the e-module petroleum based on guided discovery learning is easy to use. All aspects of the e-module construct validity of 0.89 are included in the valid category.

One-to-one evaluation(one-to-one test) The GDL-based petroleum e-module that has been made is interesting so that students are motivated to learn petroleum material. The typeface, color, and size of writing used are legible. The language used for each GDL syntax is self-guided and easy to understand, thus helping to understand concepts. Then the videos, pictures, and animations available are interesting so that it makes it easier to understand the material.

The reflections obtained from expert reviews and one-to-one evaluations are made to improve to produce a better product. The revision results resulted in a valid Guided discovery learning-based petroleum e-module.

3.2.4. Prototype III

E-modules that are valid will be evaluated through small group practicality tests on twelve students in class XI IPA 2, then 2 teachers at senior high school 1 Payakumbuh district.

3.2.4.1. Teacher practicality

The results of the overall teacher practicality obtained a value of 79.86% in the practical category. The teacher's practicality assessment is based on three components, namely ease of use with a score of 77.08%, meaning that the instructions for using the e-module are easy to use and practical in size to carry. This is following the opinion of Plomp (2013), that practicality is based on users and experts considering the product to be clear, usable, and cost-effective. Then the efficiency of learning time with the acquisition of a score of 75% shows that using GDL-based e-modules in learning petroleum becomes more efficient. Aspects of benefits with a score of 87.50%. This means that the petroleum-based e-module teaching materials based on guided discovery learning help teachers in instilling concepts in students. The results of this practicality analysis are per the provisions set by Riduwan (2007) that for the practicality criteria of teaching materials 0-20 very low, 20-40 low, 40-60 high enough, 60-80 high, 81-100 very high[24]. Teacher practicality assessment can be seen in Figure 5.

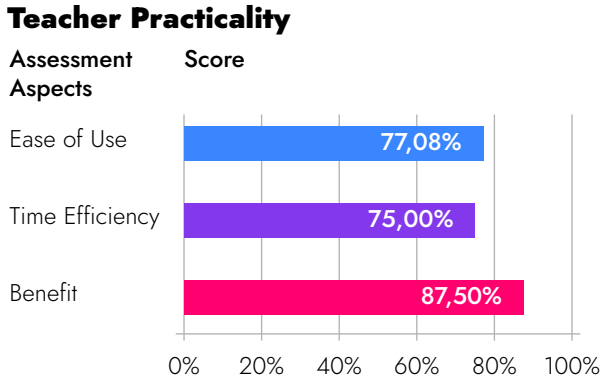

Figure 5. Results of Teacher Practicality.

3.2.4.2. Practicality of Learners

From the practicality of students as a whole obtained value84,91% with the very practical category. Following the provisions set by Riduwan that the criteria for teaching materials 81-100 are in the very practical category[24]. The practicality assessment for students consists of three components, namely ease of use with a score of 85.76%, meaning that the language used in the e-module is easy to understand and the letters used are clear to read. Then the time efficiency that learning petroleum using e-modules becomes more efficient. With an assessment obtained of 86.46%, the overall practicality assessment of students can be seen in Figure 6. The beneficial aspect of obtaining a score of 82.50% on e-module teaching materials provides benefits such as helping students find and understand petroleum material. This is following the opinion of Plomp (2013), that practicality is based on users and experts considering the product to be clear, usable, and cost-effective. The overall practicality assessment of students can be seen in Figure 6.

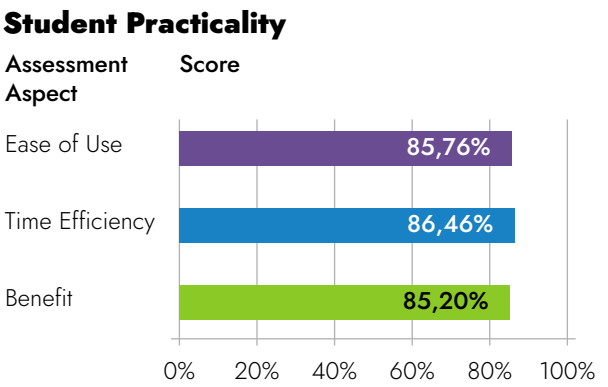

Figure 6. Results of Student Practicality.

4.SIMPULAN

Based on the results of the research that has been done, it can be concluded that the guided discovery learning-based petroleum e-module for Class XI senior high school can be developed using the Plomp development model. Then the guided discovery learning-based petroleum e-module for class XI senior high school has been developed as valid and very practical.

This research was only up to the small group. Further research is needed for field tests to determine the practicality and effectiveness on a broad scale of the developed e-modules.

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