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Development of a Problem-Solving Oriented Interactive E-Module as a Learning Media on the Topic of Biodiversity

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Abstract: The purpose of the research is to obtain an interactive e-module learning media oriented to the problem-solving skills of biodiversity materials that are valid, practical, and effective. This type of research is 4D model development research (Define, Design, Develop, Disseminate). The results found that the validity test of the assessment of material expert validators, media experts, and teachers was sequentially scored ($\bar{x}$) 95.10%, 85.83%, and 94.17% (very good). The practicality test for the implementation of learning in small groups and large group trials was scored ($\bar{x}$) 94.12%, student activity was sequentially scored 85% and 87.62%, and student responses were sequentially scored 85% and 87.9% (all of these results belonged to the category of " very practical"). The effectiveness test of the N-Gain value in small group trials (0.64 "quite effective') and large groups (0.70 "effective"). In conclusion, the module developed is valid, practical, and effective in Biology learning process at SMA Negeri 2 Gorontalo.

Keywords: e-module, problem-solving skill, research and development.

Abstrak: *Tujuan penelitian yaitu memperoleh media pembelajaran e-modul interaktif berorientasi kemampuan pemecahan masalah pada materi keanekaragaman hayati yang berkriteria valid, praktis, dan efektif. Jenis penelitian adalah penelitian pengembangan model 4D (Define, Design, Develop, Disseminate). Hasilnya ditemukan bahwa uji validitas dari penilaian validator ahli materi, ahli media, dan guru secara urut mendapat skor $\bar{x}$ 95.10%, 85.83%, dan 94.17% (sangat baik). Uji kepraktisan untuk pelaksanaan pembelajaran pada uji coba kelompok kecil dan kelompok besar masing-masing mendapat skor $\bar{x}$ 94.12%, aktivitas siswa secara urut mendapat skor $\bar{x}$ 85%, dan 87.62%, serta respon siswa secara urut mendapat skor $\bar{x}$ 85%, dan 87.9% (semua hasil tersebut termasuk kategori "sangat praktis"). Uji efektivitas dari nilai N-Gain pada uji coba kelompok kecil (0.64 "cukup efektif") dan kelompok besar (0.70 "efektif"). Kesimpulannya bahwa e-modul yang dikembangkan valid, praktis, dan efektif digunakan dalam proses pembelajaran Biologi di SMA Negeri 2 Gorontalo.*

Kata kunci: *e-modul, kemampuan pemecahan masalah, penelitian pengembangan.*

▪ INTRODUCTION

Education is an attempt to create the potential for students to produce expected behavioral changes, and also education is an attempt to shape the students to be knowledgeable, skillful (possessing a competence), and independent for preparing graduates who are qualified and can compete globally, and master technological developments (Fonda & Sumargiyani, 2018; Artika, 2019; Kanematsu & Barry, 2016). Naturally, this can not be separated from the role of teachers as professional educators who have the main task to educate, teach, guide, and also facilitate the learning process. Teacher's role as a facilitator during the learning process is expected to be able to provide materials or supporting tools to enhance an appealing and innovative learning.

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The supporting tools which is used for learning is commonly called as learning media. Learning media can be a means to convey messages and information. A well-crafted learning medium will greatly help students achieve their learning targets (Majid, 2020; Ramdhani & Muhammadiyah, 2015).

Some important things for a learning medium oriented towards problem-solving skills. Considering its importance for the students to possess this skill in their daily lives, it is undoubtedly true that students are indirectly demanded to discover a solution after being exposed to problems. A learning activity should give students an experience that train them in solving the problems. The meaning of learning can be achieved with a learning system that requires the students to solve a problem by applying students' skills, knowledge, and learning mastery in this process (Mustika & Riastini, 2017). One of Biology learning materials, biodiversity in Indonesia. Biodiversity is always used for show amount, varity and viability of live organisme (Baderan & Utina, 2021). Biodiversity examines the main problems related to the decline of biodiversity in Indonesia, one of which is caused by human activities themselves, according to Katili (2008) that human activities are due to increasing demand or human needs for goods and services provided by nature. It's encouraged the students to train their problem solving skills through problems studies in the materials. According to the interview result with a teacher of Grade X in SMAN 2 Gorontalo, it was revealed that students' mastery in solving the problem in biodiversity material was considered low. Approximately 75% of the students found difficulties in solving the problems on the assignments given by the teacher. This finding is in line with the study result of PISA in 2018 on the problem solving component, it was shown that 70% of the students in Indonesia had not reached level 2 in PISA's framework (Hidayatulloh et al., 2020).

The spread of the Covid-19 virus caused major changes for almost all aspects, including the world of education. The government made several policies to combat the Covid-19 virus, namely by physical distancing and even lockdown in some areas. This policy requires that learning must be done online, so that teachers is asked to be able to use alternative learning media that can be used online so that learning and teaching activities can run. There are several media that can be used by educators during the Covid pandemic, such as WhatsApp, YouTube, Zoom Meeting, Google Classroom, Edmodo, dan Skype (Sakkir et al., 2020; Zaini et al., 2021).

Based on the statement, an effort is needed by developing an interactive electronic learning module (e-module) that is oriented to problem-solving skills in biodiversity materials. Besides supporting the independent learning, e-module can also train the students to solve problems and can be used by students using their smartphone/android. In the current era of globalization, students already belong to the millennial generation, which the generation depends on technology from a very early age compared to the previous generation. This indicates the need for utilization of current information technology advances that can design learning materials on smartphones to make it easier for students to access them using a smartphone (Saputra & Razak, 2020; Smith & Nicholas, 2015). The e-module developed in this study taking the advantage of the advancement of technology employed Flip PDF Professional application. This application can create interactive book pages by inserting the multimedia assets such as pictures, video from YouTube, MP4, Audio-Video, quiz and this app is easier to use because it can be operated by beginners (Seruni et al., 2020).

In general, the objective of this research is to develop an interactive e-module which is problem-solving oriented which focuses on biodiversity material. The specific

aim of this study is to figure out the validity, practicality, and effectiveness of the e-module which had been developed.

▪ METHOD

This Study is a research and development which employed 4D design (define, design, develop, and disseminate) (Fradila et al., 2021). This research method refers to the steps of research and development of 4D design (define, design, develop, and disseminate). In the defining step, several smaller steps involved are front-end analysis, concept analysis, assignment analysis, and specifying the learning goals. In the designing step, the selection on the media of e-module, format, and the initial raw design of the e-module was carried out. The following step is developing that involves the validation of the e-module, revision, product tryout (small scale and big scale tryout), and final result. The final step is dissemination which was limited in this study. The research was conducted in SMAN 2 Gorontalo, Buladu Village, Kota Barat, Gorontalo City. The research was conducted in March – November 2021.

The instruments used to collect the data are as follows: a) interview instrument for the Biology teacher; b) e-module validation instrument for 2 validators of content and media experts; c) instruments for the students to respond the e-module; d) learning process sheet; e) students' observation sheet; f) assessment sheet (pre- and post-tests). The technique used to collect the data in this research are 1) interview carried out with one of the Biology teachers for grade X in SMAN 2 Gorontalo by using interview guide, 2) questionnaire used to collect the information related to the responses/assessment of the e-module which had been developed; 3) documentation it consists of names of the students as the subject of this research, and various notes supporting this research; 4) pre-tests and post-tests become the learning outcome test in this research.

The data analysis technique in this research consists of 3 kinds, i.e. the analysis of experts' validation, the practicality of the e-module, and the effectiveness of the e-module. In the analysis of experts' validation and practicality validation of the e-module, using the scoring score criteria were for a score of 4 it is shouted "Very Good", a score of 3 is shouted "Good", a score of 2 is shouted "Fair", and a score of 1 is shouted "Poor" (Situmorang et al., 2020). The percentage criteria of both analysis were delivered in Table 2 and 3 below.

Table 2. Evaluation Criteria of the Problem Solving Oriented Interactive E-module Learning Media (Nikmah & Mintohari, 2019)

No	Percentage (%)	Note	Follow Ups
1	85-100	Very Good (VG)	This new product is worth to be used in the real field for learning activities.
2	75-84	Good (G)	The product can still be used by adding some aspects which are missing from the media, making specific consideration, the choices are not too big and fundamental.
3	65-74	Fair (F)	The media is revised and rechecked meticulously and identify the shortcomings of the

			product for the perfection of the product.
4	55-64	Poor (P)	The media is totally and fundamentally revised concerning the content of the product.

Source: (Akbar, 2013).

Table 3. The Percentage Criteria of the Media Practicality

Percentage	Criteria
81% - 100%	Very Practical
61% - 80%	Practical
41% - 60%	Fairly Practical
21% - 40%	Poorly Practical
0 - 20%	Not Practical

Analysis of the effectiveness of e-modules consist of 2 aspects namely the learning outcome test (problem solving analysis) and N-Gain analysis. For the category of student problem-solving ability, if the grade obtained is between 85.00 - 100 then it belongs to the category "Very Good", if the value obtained is between 70.00 - 84.99 then it belongs to the category "Good", if the value obtained is between 55.00 - 69.99 then it belongs to the category "Fair", then it belongs to the category "Poor", and if the value obtained between 0 - 39.99 then it belongs to the category "Very Poor" (Mawaddah et al., 2015). The N-Gain analysis applied a formula as delivered below and the effectiveness criteria of the e-module, if the average value of Normalized Gain ≥ 0.70 then it includes "effective" or “high category”, if the average value of Normalized Gain ≥ 0.30 and < 0.70 then it includes "quite effective" or “medium category”, and if the average value of Normalized Gain < 0.30 then it includes "less effective" or “low category” (Suwatra et al, 2018).

$$\text{N-Gain} = \frac{post-testscore - pre-test\ score}{Maximum\ Score - Pre-Tezt\ Score}$$

▪ RESULT AND DISCUSSION

Validity of the E-Module

Characteristics of this developed e-module is a e-module that contains tasks or exercises related to problems in biodiversity materials to help students develop problem-solving skills. The indicators of problem-solving capabilities contained in this e-module include identifying problems, finding alternative solutions, choosing the right solution, implementing solutions, and evaluating the problem-solving results (Paidi, 2010). The E-Module developed contains all sub-materials in biodiversity materials, including understanding biodiversity, biodiversity levels, Indonesian biodiversity, biodiversity benefits, and preservation of Indonesian biodiversity. Problems in biodiversity material are studied in the biodiversity preservation sub-material.

Before testing the e-module that has been developed, the validation stage is carried out first. Validation was carried out by 3 validators, namely 2 lecturers as material experts, media experts and teachers at SMA Negeri 2 Gorontalo. The validity of the media must be acknowledged to decide whether the media is appropriate to be used by the teacher and students in the learning system (Syamsiah, 2019). As for the

results of the problem-solving ability-oriented e-module validation on biodiversity materials, for expert validation the material gets an average score of 95.10%, the validation of media experts gets an average score of 85.83%, and teacher validation gets an average score of 94.17% all three results are included in the "Very Good" criteria. This is in line with research conducted by Komikesari et al (2020), where the results of media expert validation get an average score of 89.1%, material expert validation gets an average score of 92.08%, and validation of religious experts gets an average score of 90%, for all three results including the criteria "Very Good". This is supported by Akbar (2013) stating that the validity criteria of a product implemented for learning with achievable score as big as 85% - 100% is considered as “very good” media, where the development product can be beneficial for learning activities. Here is an image of the completed validated e-module.

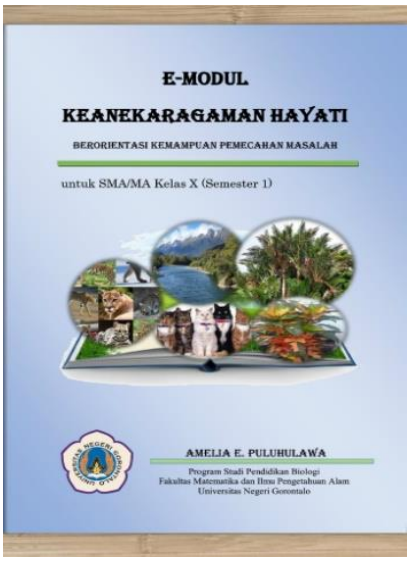

Figure 1. E-Module Cover

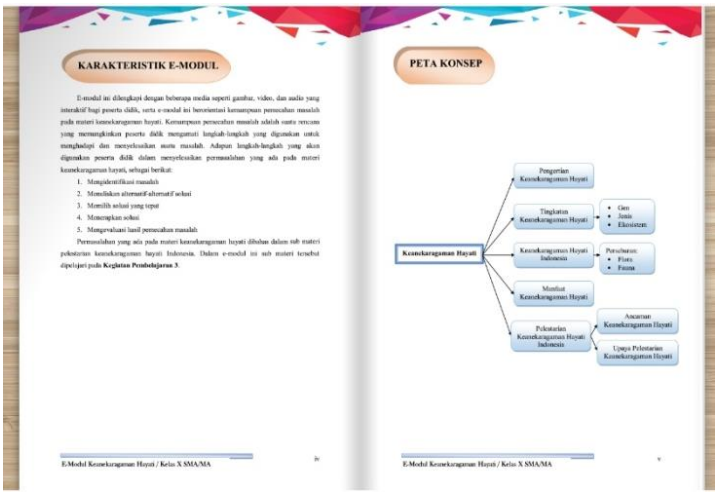

Figure 2. E-Module Characteristics View, and Concept Map

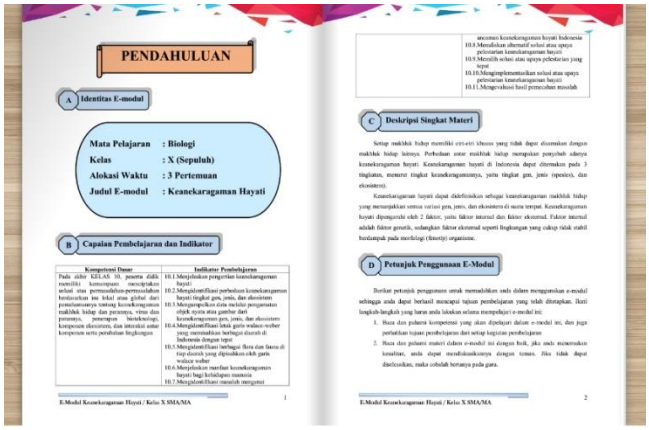

Figure 3. Introduction Chapter View

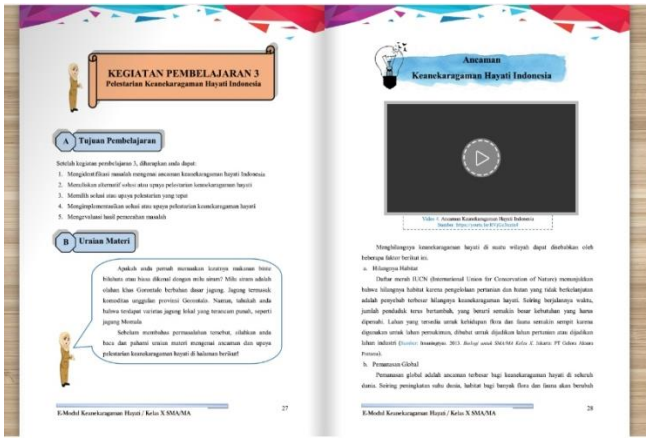

Figure 4. Learning Activity Chapter View

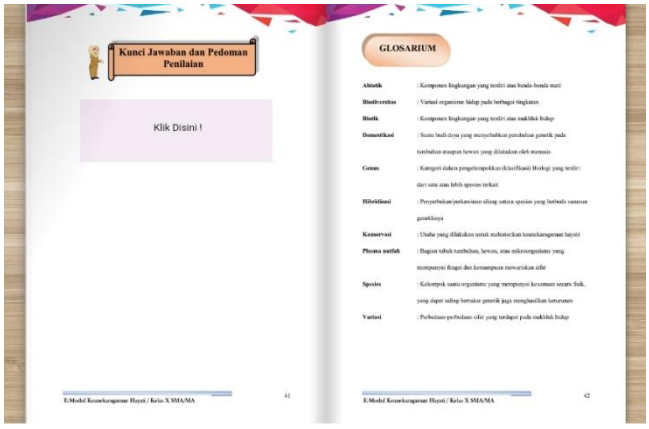

Figure 5. Answer Key View and Assessment Guidelines, as well as Glossary

E-Module Practicality

1. The Realization of Learning Activities (Teachers' Activities)

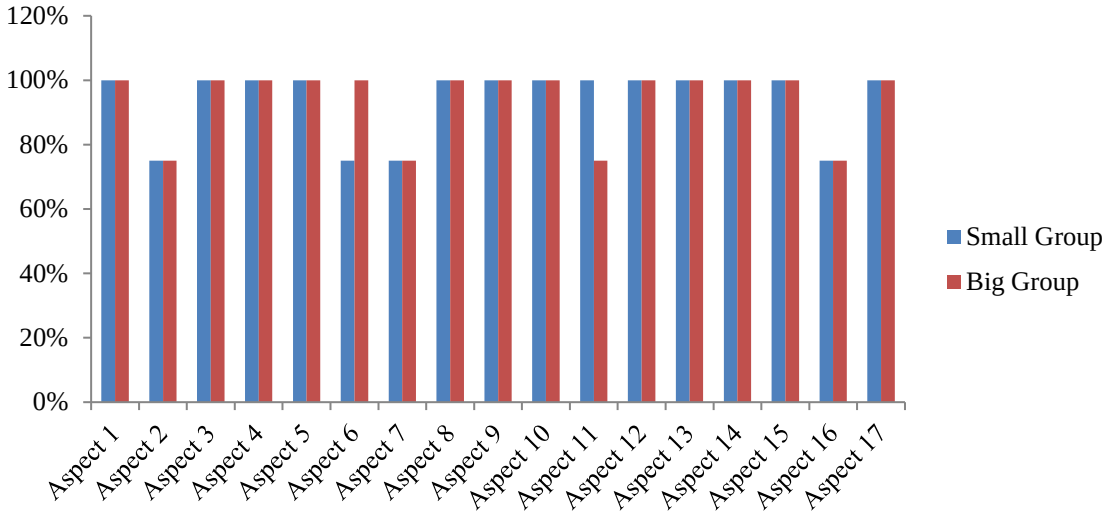

Figure 6. Graphic on the Result of the assessment on the Realization of Learning Activities (Small & Big Scale Try-out)

Note:

Aspect 1	:	Greeting, praying, preparing the class, and checking students' attendance
Aspect 2	:	Administering pre-test
Aspect 3	:	Delivering an apperception as well as motivating the students
Aspect 4	:	Asking the students to access the E-Module on Activity 3
Aspect 5	:	Telling the learning goals
Aspect 6	:	Asking the students to read or watch the video about the sub material on the threats and attempts in preserving biodiversity
Aspect 7	:	Asking the students to read the sample problems and together with the students answer the questions related to the sample problems
Aspect 8	:	Giving a reinforcement towards the result of problem solving
Aspect 9	:	Dividing the students into some groups
Aspect 10	:	Asking the students to do a group work and distributing the worksheet to each group as well as limiting the duration in completing the group work
Aspect 11	:	Advising the students in doing a problem solving in the group work according to the steps of problem solving
Aspect 12	:	Asking the group representatives to present the result of the group discussion in front of the class
Aspect 13	:	Together with the other group responding the result of group presentation of the presenters to evaluate the result of the problem solving
Aspect 14	:	Giving appreciation to the group who had presented the result of the discussion
Aspect 15	:	Together with the students drawing conclusion
Aspect 16	:	Administering a post-test
Aspect 17	:	Closing the learning activity by greeting and saying *hamdalah*

Based on the assessment results from the observer on the small and big scale try-out both obtained similar average score that was 94.12% and was categorized as “very practical”. If the percentage of the learning realization acquired 91.67% it was categorized “very practical” which means that the learning activities had ran appropriately as has been planned in the lesson plan (Barata, 2015). If the implementation of learning (teacher activity) gets the criteria "very practical" then it indicates that the e-module developed is easy to use and friendly to users (Husna et al., 2021). However, if seen from the graphic particularly for aspects 2, 7, and 16, the score obtained for the big-scale try-out was still 75%. This means that the teacher has not performed maximally in that aspect. A difficult indicator to accomplish on aspect 2 and 16 is adjusting the timing with the students in completing the pre- and post-test so that more time was spent for that. Thus, the teacher needs to pay attention to time allocation which is suitable with what has been planned in the lesson plan. Another factor needed to be regarded is the time allocation for evaluation session (Handayani, 2014). Then, for aspect 7, the difficult indicator to realise is the participation of the students in giving answers towards the sample problems, so that teachers became the one who actively gave the answers.

2. Students’ Activities

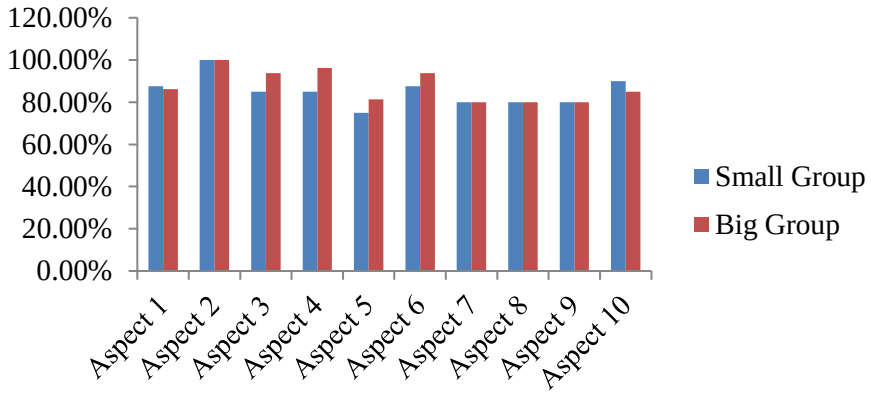

Figure 7. Graphics on the Results of Students’ Activities Assessment (Small and Big Groups)

Note:

Aspect 1	:	Doing the pre-test
Aspect 2	:	Observing the apperception
Aspect 3	:	Reading or watching the video related to the materials in the E-Module
Aspect 4	:	Reading and observing the sample problems in the E-Module
Aspect 5	:	Answering the questions related to sample problems
Aspect 6	:	Having a discussion with peers in a group and writing the discussion result on the worksheet
Aspect 7	:	Presenting the result of group discussion
Aspect 8	:	Responding the presenter (in the form of additional materials or questions)
Aspect 9	:	Drawing conclusion from the learning materials
Aspect 10	:	Doing a post-test

The assessment result of students' activities during the small-scale try-out acquired an average score as big as 85% from all evaluation aspects while in the big-scale try-out, the average score was 87.62% from the whole aspect assessed. These two results are categorized as "very practical". This implies that students' activities during the learning process that employed the problem solving oriented interactive e-module learning media has been successfully realized appropriately. This result echoes the previous research by Setiawan (2021) which proved that the assessment of students' activities during a limited try-out acquired average score 85.23% and the main try out 85.4% in which both were categorized as "very practical" with splendid percentage. Modul yang berbasis masalah dapat meningkatkan aktivitas dari siswa untuk dapat memecahkan permasalahan (Uz et al., 2019). However, according to the graphic, it can be seen that there are 3 aspects generating identical score, whether it is on the small and big scale try-out. This is because there are only few students who were actively participating in realizing the third aspect.

3. Students' Response

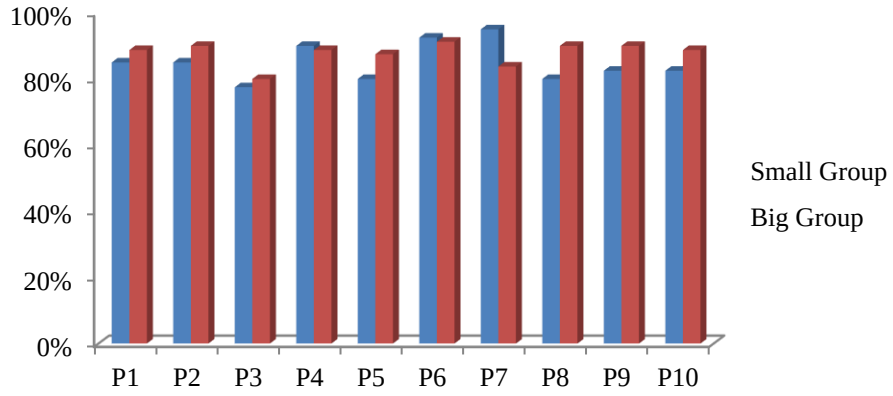

Figure 8. Graphic on the result of students' response (Small and Big Groups)

Note:

P 1	:	I can use the E-Module easily.
P 2	:	The appearance of the E-Module is interactive and interesting.
P 3	:	The E-Module loads picture, audio, and video.
P 4	:	The Materials provided in the E-Module are clear and understandable.
P 5	:	The picture, audio, and video are suitable with the materials.
P 6	:	The language use in the Module is understandable.
P 7	:	The font used in the test on the E-Module is readable and clear
P 8	:	The sample of problems, assignment, exercises in Activity 3 in the E-Module help me to develop my problem solving skills.
P 9	:	Using the E-Module makes me more motivated to learn.
P 10	:	The E-Module can be used to support my independent learning particularly in problem solving.

Students' responses towards the interactive E-Module learning media which is problem solving oriented during the small scale try-out acquired an average score as big as 85% while in the big scale try-out 87.9%. From these two try-out results, it can be revealed that the interactive E-Module learning media which is problem solving

oriented is perceived “very practical” to be used for learning. This is in line with the serevina et al (2018) study where the results of the student's response received an average score of 80.78% including the criteria of "Very Good". The criteria of the product developed in this study is considered “very practical” if the percentage of the responses from the students reached between 81% - 100% (Nikmah & Mintohari, 2019).

The Effectiveness of the E-Module

1. Students’ Learning Outcome

The students’ result on the pre-test on problem solving skill during the small-scale try-out obtained average score as big as 41.33 while in the big-scale try-out acquired average score 41.67. Based on these two results, the criteria of students’ problem-solving skills are considered “poor”. According to Mawaddah (2015), score 40.00 – 54.99 is considered “poor”. The students’ result on the problem solving skill improved from the pre-test. It can be seen from class average score during the small scale try-out which obtained 78. However, the average score of the big group during the try-out achieved 82.33. From these two results, the criteria of students’ problem solving is considered “good”. According to Mawaddah (2015), score ranging from 70.00 – 84.99 is considered “good”. This proves that students’ problem solving skill has improved after knowing how to make use of the E-Module learning media which was developed to sharpen students’ critical thinking skill. There are several factors affecting students’ problem solving skill, one of which is the learning media applied during the learning activity. The other reason causing student’s low effort in achieving the maximum learning result is due to peer conversation that happen during the learning process as well as group discussion which was beyond the discussion topic (Artinta & Fauziah, 2021; Prakoso et al., 2015).

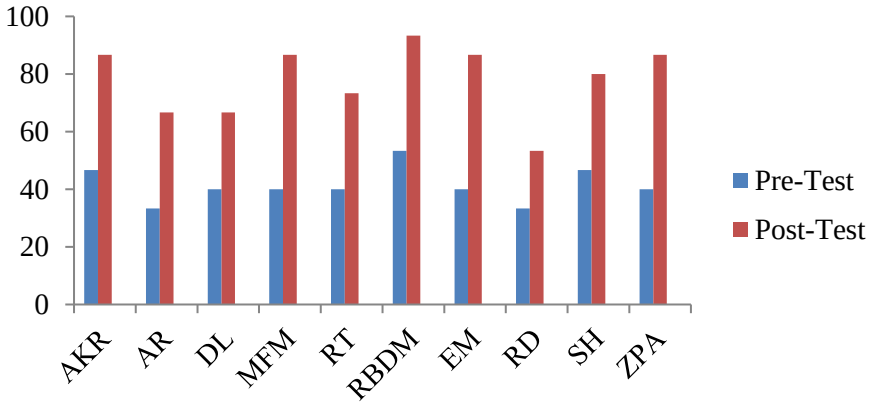

Figure 9. Graphic on the Result of Students’ Pre- and Post-Test (Small Group)

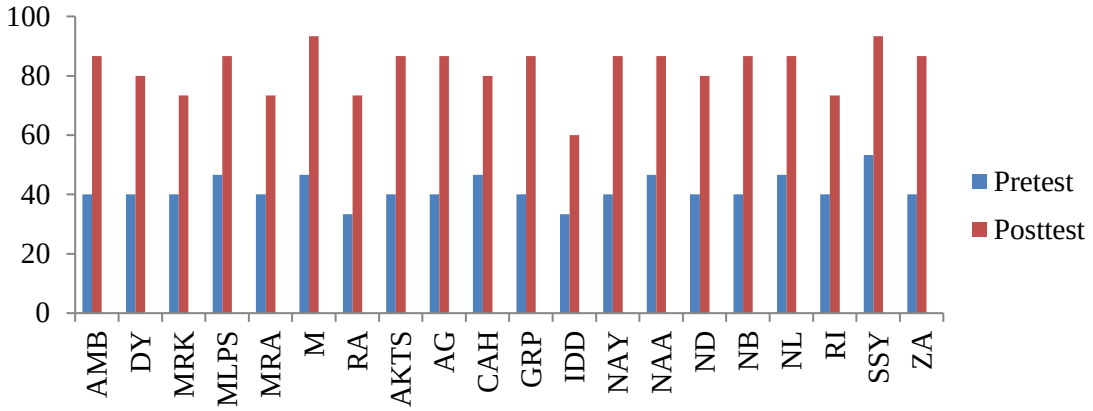

Figure 10. Graphic on the Result of Students' Pre- and Post-Test (Large Group)

2. N-Gain Result

The interpretation of the average score of the N-Gain during the limited try-out obtained a score as big as 0.64 which was categorized as "medium" which means "fairly effective". Meanwhile, the main try-out reached 0.70 which was categorized "high" which means "effective". Both results are in line with Pratama (2018) revealing that the N-Gain score ≥ 0.70 was considered "Effective", ≥ 0.30 and < 0.70 was considered "fairly effective". In the study Hutomo et al (2022) tested e-modules developed in two different classes and the n-gain results of both classes were categorized as "high" or "effective", namely 0.72 and 0.71. According to the N-Gain result of the main try-out proved that the implementation of the problem solving oriented interactive e-module learning media is considered effective in improving students' learning outcome.

Table 7. The Result of N-Gain score (Small Group)

No	Students' Names	Pre-test	Post-test	N-Gain
1	AKR	46.67	86.67	0.750047
2	AR	33.33	66.67	0.500075
3	DL	40	66.67	0.4445
4	MFM	40	86.67	0.777833
5	RT	40	73.33	0.5555
6	RBDM	53.33	93.33	0.857082
7	EM	40	86.67	0.777833
8	RD	33.33	53.33	0.299985
9	SH	46.67	80	0.624977
10	ZPA	40	86.67	0.777833
Average				0.64

Table 8. The Result of N-Gain Score (Large Group)

No	Students' Names	Pre-test	Post-test	N-Gain
1	AMB	40	86.67	0.777833
2	DY	40	80	0.666667
3	MRK	40	73.33	0.5555
4	MLPS	46.67	86.67	0.750047
5	MRA	40	73.33	0.5555

6	M	46.67	93.33	0.87493
7	RA	33.33	73.3	0.59997
8	AKTS	40	86.67	0.777833
9	AG	40	86.67	0.777833
10	CAH	46.67	80	0.624977
11	GRP	40	86.67	0.777833
12	IDD	33.33	60	0.40003
13	NAY	40	86.67	0.777833
14	NAA	46.67	86.67	0.750047
15	ND	40	80	0.666667
16	NB	40	86.67	0.777833
17	NL	46.67	86.67	0.750047
18	RI	40	73.33	0.5555
19	SSY	53.33	93.33	0.857082
20	ZA	40	86.67	0.777833
	Average			0.70

▪ CONCLUSION

Based on the results of the study, for the validity assessment of e-modules received an average score from material experts, media experts, and teachers in sequence, namely 95.10%, 85.83%, and 94.17% of the three results belonged to the category of "excellent". For the practicality assessment of the e-module tie the results of learning implementation (teacher activity) in small group and large group trials received the same average score of 94.12%, student activity results for small group trials and large groups received average scores in sequence of 85% and 87.62%, and the results of student response in small group and large group trials received an average score in sequence of 85%, and 87.9% (all such results fall into the category of "very practical"). For the effectiveness assessment of e-modules based on N-Gain results for small group trials got a score of 0.64 "quite effective" and for large group trials got a value of 0.70 "effective". Thus, e-module developed in this study is valid, practical, and effective to be used in learning process for Biology Subject in SMAN 2 Gorontalo. This e-module is piloted only on 3 learning activities that are oriented to problem-solving skills, so further research is needed to apply all the learning activities in the e-module. In the field of education, this e-module has an impact that can improve students' problem-solving skills through problems studied in biodiversity materials.

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