Journal of Education Technology
Volume 6, Number 4, 2022 pp. 744-754
P-ISSN: 2549-4856 E-ISSN : 2549-8290
Open Access: https://ejournal.undiksha.ac.id/index.php/JET

E-Modules Through Flipped Classroom and PBL Models on Environmental Pollution Material to Increase Problem-Solving Ability

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ARTICLE INFO

Article history:
Received August 04, 2022
Revised August 11, 2022
Accepted November 03, 2022
Available online November 25, 2022

Kata Kunci:
3-Module, Flipped Classroom, Problem Based Learning, Problem-Solving, Kemandirian

Keywords:
E-Module, Flipped Classroom, Problem Based Learning, Problem-Solving Ability

DOI:.
https://doi.org/10.23887/jet.v6i4.51656

ABSTRAK

Kurangnya pengetahuan pendidik mengenai teknologi, informasi dan penggunaan media pembelajaran dapat meningkatkan kebosanan belajar yang menyebabkan siswa kurang mengerti dengan materi yang disampaikan oleh guru. Sehingga perlu adanya suatu inovasi agar memberikan dampak positif kepada peserta didik dengan menggunakan media. Penelitian ini bertujuan untuk mengembangkan e-modul berbasis android mobile pada materi pencemaran lingkungan. Jenis penelitian ini yaitu pengembangan. Penelitian menggunakan metode research and development. Subjek uji coba adalah 72 siswa. Teknik sampling menggunakan probality sampling dengan metode simple random sampling. Metode yang digunakan untuk mengumpulkan data yaitu wawancara, kuesioner, dan tes. Instrument yang digunakan untuk mengumpulkan data yaitu lembar wawancara, angket, soal tes. Pada uji keefektivitas e-modul menggunakan quasi experiment non-equivalent pretetst-posttest control group design. Hasil penelitiaan menyatakan penggunaan e-modul berbasis android layak digunakan pada pembelajaran materi pencemaran lingkungan. Disimpulkan bahwa e-modul berbasis android mobiledapat meningkatkan kemampuan pemecahan masalah peserta didik SMA Kelas X pada mata pelajaran biologi. E-modul berbasis android dapat membantu siswa dalam belajar.

ABSTRACT

The lack of educator knowledge regarding technology, information, and the use of learning media can increase learning boredom which causes students to lack understanding of the material presented by the teacher. So there needs to be innovation in order to have a positive impact on students by using the media. This study aims to develop an android mobile-based e-module on environmental pollution material. This type of research is development. Research using research and development methods. The test subjects were 72 students. The sampling technique uses probability sampling with the simple random sampling method. The methods used to collect data are interviews, questionnaires, and tests. The instruments used to collect data were interview sheets, questionnaires, and test questions in testing the effectiveness of the e-module using a quasi-experimental non-equivalent pretest-posttest control group design. The results of the research stated that using Android-based e-modules was appropriate for learning environmental pollution material. It was concluded that the e-module based on android mobile could improve the problem-solving skills of Class X high school students in biology subjects. Android-based e-modules can help students learn.

1. INTRODUCTION

Education is the only place of activity that can be seen and functions to create high-quality human resources (Cross & Congreve, 2021; Dolapcioglu & Doğanay, 2020). Education in accordance with the development of the 21st century relies more on developing skills that include thinking, problem-solving, and communication skills that support the optimization of the educational attainment process (Dullea, 2019; Gilbert, 2021; Gren et al., 2020). The 2013 curriculum emphasizes a teacher-centered learning approach to a learner-centered learning approach and the existence of learning activities in the form of experience that requires students to do authentic learning (Hariyanto et al., 2022; Sakib et al., 2019). Authentic learning can occur when teachers provide appropriate learning opportunities so students can think scientifically, solve problems, think critically (Farrell, 2022; Pallant et al., 2022; Singer et al., 2020), and reflect on issues in everyday life (Tumilty et al., 2022; Yang & Miang Goh, 2022).

The flipped classroom can be a learning model that allows students to cultivate their own learning environment and increase their motivation to solve problems (Alali, 2020; Chua & Islam, 2021; Singh et al., 2021). The class is not the only one for students to learn, but on the contrary, students can learn anytime and anywhere using highly advanced information technology (Rehman & Fatima, 2021). The combination of PBL

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and flipped classrooms creates a learning atmosphere for edutainment and authentic learning (Desai et al., 2018; J. L. Leatherman & Cleveland, 2020). Flipped Classroom is based on the principle of edutainment learning because it creates an active learning environment. Through videos, learning can be done anytime and anywhere, not limited to classrooms. Problem Based Learning focuses students on solving problems. Thus, the combination of FC and PBL allows students to spend time outside the classroom to learn, and inside to solve problems (Gough et al., 2017; Rehman & Fatima, 2021). Empirical evidence that the problem-based flipped classroom model is effective for improving students' problem-solving skills is the research result through the application of the problem-based flipped classroom learning model to improve students' problem-solving skills (Alebrahim & Ku, 2020). In line with this, stated that the problem-based flipped classroom model was effectively used to improve students' problem-solving skills (Chua & Islam, 2021).

The development of technology and communication also affects the world of education and can help educators to be able to innovate in the development of teaching materials (Daryono et al., 2021; Kusuma et al., 2021). Based on these problems, the solution chosen to overcome the problem so students can learn independently and increase learning motivation is to develop E-module teaching materials. E-modules are interactive, making them easier to navigate, display images, text, and videos equipped with tests, and automatically provide feedback (Rehman & Fatima, 2021; Vitoria et al., 2018). E-module is a digitally packaged teaching material (Daryono & Rochmadi, 2020; Resita & Ertikanto, 2018; Tan & Hsu, 2018). E-modules packaged in digital form can not only be read through a laptop or computer but, along with technological developments, can also be developed through an Android smartphone.

Studying biology is not only about learning about concepts and theories (Farias et al., 2022; Priemer et al., 2020). Students also need to know to observe various symptoms in life so that they can formulate multiple life problems and provide solutions to solving them (Farias et al., 2022; Mkimbili, 2022). Effective learning can do by giving real issues relevant to the needs of students so that students do not just accept (Farias et al., 2022; Kocuk, 2022; Mkimbili, 2022; Wu et al., 2021). In problem-solving ability, students in Indonesia are still relatively low (Apino & Retnawati, 2017; Arga et al., 2022; Heru et al., 2021; Riastuti et al., 2017). The biology learning material raised in the development of an android-based e-module is environmental pollution material for class X SMA. The essential competencies to be achieved are 3.11 Analyzing data on environmental changes, their causes, and impacts on life and 4.11 Formulating ideas for solving problems of environmental change that occur in the surrounding environment. Implementation of the 2013 curriculum which carries character education in schools, this awareness can be realized. Through environmental pollution material, the character of students can be built, especially the nature of caring for the environment because this material is closely related to human life and the environment around his life.

The observations and interviews with teachers of SMA N 2 Bantul revealed that students' problem-solving abilities were still relatively low, which scored 54%. That was because first, students tend to be bored at the beginning of learning because the material provided is limited to concepts and does not take advantage of school facilities (Rahmatunisa, Sofyan, Daryono, et al., 2022). Second, there is no use of the surrounding environment as a source of learning, especially environmental pollution material (Cheeseman & Wright, 2019; Eppinga et al., 2019; Li et al., 2021). In addition, educators need to provide varied learning so that students are not bored during the classroom learning process (Amhag et al., 2019; Keenlyside, 2021). Lack of knowledge of educators about technological advances, information, and the use of improvised and monotonous learning media can increase learning boredom which causes students to lack understanding of the material presented by the teacher, so there is a need for an innovation to have a positive impact on students by using media.

The complete nature of Android allows software makers to make approaches to developing software freely, Android is also a safe operating system, and many tools are available for building software. Android is provided openly, so developers are free to develop applications. From the distribution of the questionnaire on student needs at SMA N 2 Bantul, almost 99% of students have an Android smartphone and are allowed to bring a smartphone to school. Responding to these problems and the results of observations, interviews, and the distribution of student need questionnaires that have been carried out, 96% of SMA 1 Sleman are interested in the development of interactive learning media that can accessed on their respective smartphones and by following the demands of the development of the industrial revolution 4.0 era. So the researcher intends to develop an android-based e-module to improve the problem-solving skills of X SMA students on environmental pollution material.

2. METHOD

The product developed in this research is an e-module based on android mobile on environmental pollution material. This development is the development of an Android-based e-module that is packaged in the

form of an application and can be accessed on a smartphone. E-modules on Android mobile contain learning materials, learning activities, social networks, and assessments/evaluations. This android-based mobile e-module is expected to improve class X high school students' problem-solving skills. The development model used in this study is the ADDIE (Analyze, Design, Develop, Implement and Evalute) development model (Trust & Pektas, 2018; Yu et al., 2021).

At the analysis stage, which is the stage to find out what problems are at the time of learning biology. At the design stage, it includes the preparation of biology learning tools consisting of a syllabus and Learning Implementation Plan and the design of the basic framework for making android-based e-modules and making e-module storyboards. The development stage is the preparation of an Android-based e-module product that is adapted to the story board until it becomes a product that is ready to be tested in the field. The implementation stage is the product stage that has been declared feasible by the validators to be tested using a quasi-experimental method with a non-equivalent pretest-posttest control group design. The test subjects were 72 students in SMA 2 Bantul which were divided into control class and experimental class.

The implementation stage is the product stage that has been declared feasible by the validators to be tested in the field according to the schedule for environmental pollution materials at SMA 2 Bantul. This e-module trial was conducted to determine the product's effectiveness in measuring problem-solving abilities during learning activities. The evaluation stage aims to analyze the existing deficiencies in the product that has been developed. Evaluation of the ADDIE model consists of formative assessment and summative evaluation. The formative assessment aims to see the feasibility of an Android-based mobile e-module in the Flipped Classroom and PBL models on environmental pollution materials (Alali, 2020; Alebrahim & Ku, 2020).

The e-module product trial used a quasi-experimental method with a non-equivalent pretest-posttest control group design (Arga et al., 2022; Petridou et al., 2017; Zong & Zhang, 2019). The test subjects were 72 students divided into two classes, namely 36 students in class X MIPA 1 and 36 students in class X MIPA 2. In testing the effectiveness of this Android-based e-module using a quasi-experimental non-equivalent pre-test-posttest control group design. The limited test aims to determine the feasibility and readability of an Android-based e-module developed using an assessment questionnaire. The responses of biology teachers and students in the limited test were analyzed to be used as improvements to the e-module during field trials. The selection of trial sample used cluster random sampling, namely the selection of the class as the experimental class and as the control class. From the results of the draw, it was found that class X MIPA 1 was the control class and X MIPA 2 was the experimental class.

The interview guide is a collection of interviews to collect the initial information needed for this research. Some critical information through interviews with biology teachers at schools is the biology learning process that takes place in the classroom, the problems experienced during the biology learning process, the learning methods/strategies/models used, the media and teaching materials used, the use of technology in the learning process, availability of facilities and infrastructure. The problem-solving test instrument is used to measure the level of problem-solving abilities of students before (pre-test) and after (post-test) the use of mobile android-based e-modules in biology learning activities. The test instrument used is in the form of an essay. The following is a grid of problem-solving test instruments that can be seen in Table 1.

Tabel 1. Problem-solving Test Instrument Grid

Indicators of Competence Achievement	Problem-solving indicators	Sub-Indicator Aspect Problem-solving Ability
Analyze and express opinions related to problem-solving in an ecosystem.	Identify	The ability of students to receive the information contained in the discourse/questions and the power of students to choose essential and unimportant information
	Problem	The ability of students to relate existing information so that they can formulate problems
	Formulate the Problem	The ability of students to process information
	Organizing information	The ability of students to apply solutions/problem-solving methods
	Solution the problem	The ability of students to choose the method of completion

(Farias et al., 2022; Kocuk, 2022; Mkimbili, 2022; Suwono et al., 2021).

The android-based e-module assessment instrument uses a Likert Scale which is then analyzed descriptively quantitatively. The quantitative data is then converted into qualitative data and refers to the interpretation of the product criteria in Table 2. The data generated in the pre-test and post-test describe the value of problem solving of students. Analysis of problem solving was carried out using the *Normalized Gain Score*

(N-gain) (Table 3). The interpretation of problem solving and independent learning is declared successful if the student's score is at least 76.00%.

Table 2. Product Eligibility Criteria Interpretation Table

Formula	Score Interval	Category
Mi + 1.5 Sbi < $\bar{X}$ ≤ Mi + 3.0 Sbi	3.26 < $\bar{X}$ ≤ 4.00	Very good
Mi + 0 Sbi < $\bar{X}$ ≤ Mi + 1.5 Sbi	2.51 <$\bar{X}$ ≤3.25	Well
Mi – 1.5 Sbi < $\bar{X}$ ≤ Mi + 0 Sbi	1.76 < $\bar{X}$ ≤ 2.50	Not good
Mi − 3.0 Sbi < $\bar{X}$ ≤ Mi – 1.5 Sbi	1.00 < $\bar{X}$ ≤ 1.75	Very Not Good

Table 3. Interpretation of N-gain Criteria

Score Interval	Category
g > 0.71	High
0.31 < g ≤ 0.70	Medium
g ≤ 0.30	Low

3. RESULT AND DISCUSSION

Result

This android-based e-module development research begins with an analysis of learning needs. A needs analysis was carried out by observation, in the form of questionnaires to students and teachers, as well as interviews with biology teachers on biology learning, especially environmental pollution material in several high schools in Yogyakarta. Based on the results of observations and interviews, the teacher's learning model is still conventional, namely using the lecture and discussion method. The media used are also still using power points and printed books as learning resources and have not utilized technology optimally in media/learning resources to support learning activities. In addition, the use of infrastructure facilities has not been utilized properly, and the limited time at school makes the learning process not optimal.

From the results of observations and interviews conducted in several schools, researchers are interested in developing e-module learning media based on android mobile environmental pollution material to improve students' problem-solving abilities and utonomy learning. The stage begins with determining the KI (core competence) and KD (basic competence), then describing the achievement indicators. The materials used are environmental pollution and the causes of environmental pollution, the impact of environmental pollution, prevention of environmental pollution, and waste recycling. Afterward, the researcher determined the concepts in the form of material packaged in detail with relevant images. The e-module also contains learning videos that support students' understanding.

At this design stage, learning tools are prepared, including the syllabus for learning and the Learning Implementation Plan (RPP),and problem-solving instruments,. Then, make a storyboard of the e-module product based on Android mobile, which will be used to develop the e-module. E-module products will create In the form of a Home button: Login (personal identity), Menu Page: (1.) Application instructions, (2) Introduction, (3) KI & KD, (4) Materials (Concept map, Activity Material 1, and LKPD, Activity Material 2 and LKPD, Material for activity 3 and LKPD), (5) Bio info, (6) Evaluation (pretest-posttest), (7) Quiz, (8) Glossary, (9) Bibliography, (10) Author. The e-module learning media was developed using the android studio application version 3.1.4, which has been designed and validated by media experts so that it becomes a product that is ready to be downloaded via the internet and implemented. Figure 1 shows the development of android-based e-module media through flipped clasroom and pbl models on environmental pollution materials to improve problem-solving ability and independence students.

Figure 1. The display of the development of the Android-based E-module media

At this stage is the testing stage of the e-module product that has been validated and declared feasible by the validator to be implemented in environmental pollution learning activities according to the semester program at the school that will be used as a research site. This trial phase is to determine the effectiveness of the e-module based on Android mobile in improving students' problem-solving abilities. In this cob test using a quasi-experimental method (quasi-experimental) with a non-equivalent pretest-posttest control group design, 72 students in this trial were divided into control and experimental classes at SMA N 2 Bantul. The trial stages can be seen in detail in the "product trial" section.

After going through each stage of planning, development, and implementation, the next stage is evaluation. Supervisors evaluate the analysis and planning stages, and experts in their respective fields carry out the development stage. At the evaluation stage, the analysis to the development stage is to see the feasibility of the product, it is to evaluate the product being tested in the field. The evaluation phase aims to determine whether the product based on this Android mobile e-module is effective in improving students' problem-solving abilities. After being tested and declared feasible, the next stage of the Android-based e-module will be published on Google Playstore or used as additional learning media for teachers.

The android-based e-module product in the Flipped Classroom model of the PBL combination was tested through a limited test on students and biology teachers of SMA 2 Bantul. The little test aims to determine the feasibility and readability of an Android-based e-module developed using an assessment questionnaire. The response of biology teachers and students to the limited test. The results of the limited trial assessment will be analyzed to be used as e-module improvements during field trials.

The limited trial is a student assessment of the Android-based mobile e-module on a small/limited scale, which helps know the student's response to the Android-based mobile e-module product that it developed before being tested on a field scale or a broader scale. This limited trial was conducted at SMA 2 Bantul with ten students. The product response questionnaire consists of 22 statements. The following data results from the limited trial assessment can be seen in Table 3.

Table 3. Limited Trial Assessment Results Data

No	Assesment Aspect	Score	Interval Score	Description
1	Material Aspect	3.39	$3.25 \leq M \leq 4.00$	Very Good
2	Aspects of Ease of Operation	3.21	$2.50 \leq M \leq 3.25$	Good
3	Aspects of Attractiveness Display	3.47	$3.25 \leq M \leq 4.00$	Very Good
Average			**3.67**	**Very Good**

Based on Table 3, the assessment of android-based e-module products by students in the limited test on the material aspect got a score of 3.39, the ease of operation aspect got a score of 3.21, and the attractiveness aspect of the display got a score of 3.47. The final average of the results of the limited trial on the product is a score of 3.67, with excellent information so that the e-module product based on Android mobile gets a good response from students. The results of the conversion of the Android-based mobile e-module assessment by students in the field test can be seen in the following Table 4.

Tabel 4. Assessment of e-module based on android mobile by students

No	Assessment Aspect	Score	Score Interval	Description
1	Material Aspect	3.10	$2.50 \leq M \leq 3.25$	Good
2	Aspects of Ease of Operation	3.22	$2.50 \leq M \leq 3.25$	Good
3	Aspects of Attractiveness Display	3.35	$3.25 \leq M \leq 4.00$	Excellent
Average			**3.51**	**Excellent**

Based on Table 4, the Android mobile-based E-module in the material aspect obtained a score of 3.10 with Good criteria. In the aspect of ease of operation, it gets a score of 3.22 in the Good category. In the aspect of attractiveness, it gets a score of 3.35 with Excellent criteria. From these three elements, it can be concluded that android-based e-modules get an average value of 3.51, with the Excellent category used in the learning process of environmental pollution materials. This prerequisite test is carried out before the hypothesis test is carried out to meet the desired requirements. The prerequisite test includes the normality and homogeneity tests for the problem-solving ability variable. The measurements carried out have the pretest value and the post-test value. Normality Test of Problem-Solving Ability showed in Table 5.

Tabel 5. Normality Test of Problem-Solving Ability

	Class	Kolmogorov-Smirnova			Shapiro-Wilk		
		Stat.	df	Sig. (ρ-value)	Stat.	df	Sig. (ρ-value)
Pretest	Experiment	0.119	36	0.200	0.962	36	0.256
	Control	0.155	36	0.028	0.953	36	0.127
Postest	Experiment	0.157	36	0.025	0.933	36	0.030
	Control	0.145	36	0.055	0.951	36	0.112

Based on the Table 5 for the normality test, the significance level shows that the pre-test and post-test values of problem-solving abilities for the control and experimental classes are normally distributed; this is known to have a significant level of more than 0.005 or ρ >0.005. So it can conclude that all data are typically distributed. This homogeneity test is used to find out about the data from each of the variables measured in the control class and whether the experimental type there is a homogeneous data variance or not. Analysis of the homogeneity test data in this study used the Levene test on the SPSS version 27 application. Based on data analaysis, the mean in the pretest, post-test, and problem-solving shows that the value of sig. >0.05. So it can be concluded that there is no difference between the control and experimental classes in the variance of students' problem-solving abilities, or it can also be called the results of the data above are homogeneous.

After the prerequisite test has been carried out, a hypothesis test is used to determine the effectiveness of android-based e-modules in improving problem-solving abilities. The results of the prerequisite test data show that the problem-solving ability is said to meet the requirements to be tested parametrically, using the independent sample t-test. Based on the results of the Independent Sample T-Test, it can see that the t value for problem-solving ability is 3.905, and the sig (2-tailed) value is 0.001. Because sig (2-tailed) 0.001 < 0.005 then H0 is rejected. So that there is a significant difference in increasing problem-solving abilities using e-modules based on android mobile, and it can conclude that android-based e-modules are effective for improving students' problem-solving skills between the control and experimental classes.

Discussion

There was a difference in the increase in the results of problem-solving abilities between the control class and the practical class after doing the posttest. Figure 2 shows the difference in improving problem-solving results.

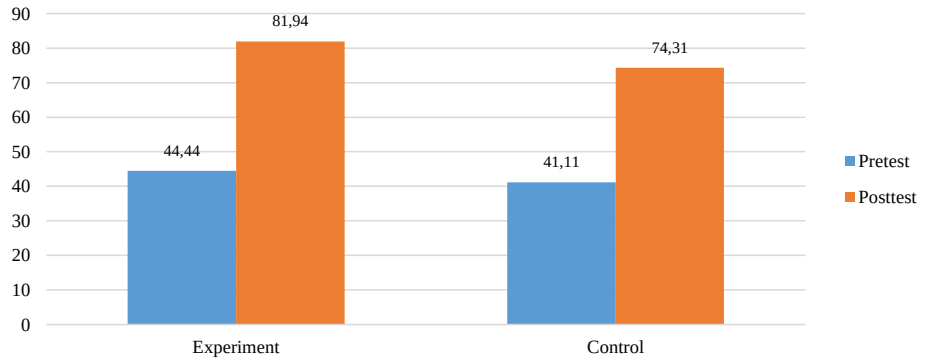

Figure 2. Comparison Chart of Average Problem Solving Ability

The results of the comparison of the average value between the control class and the experimental class from the diagram above are also strengthened by the data from the analysis of the Independent Sample T-Test test, namely sig (2-tailed) 0.001 < 0.05. It proves that android-based e-modules can improve students' problem-solving abilities. Apart from being based on the Independent Sample T-Test, an increase in problem-solving abilities between the two classes can be seen from the results of the N-gain score. The result of N-gain in the control class is 0.55, while for the experimental type, it is 0.66. The n-gain value in control and practical courses is in the medium category, but the n-gain score in the suitable class is higher than in the control class. So it can conclude that the improvement of problem-solving ability. The improvement of problem-solving ability can also being see in the experimental and control classes' indicators of problem-solving ability. The following is a diagram (Figure 3) of the posttest results between the two classes.

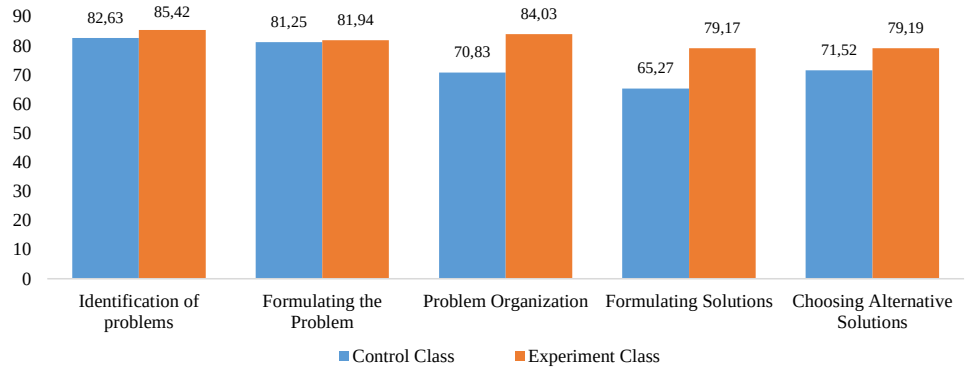

Figure 3. Comparison Diagram of Problem Solving Indicator Posttest Values in Control and Experiment Class

The increase in problem-solving abilities in the experimental class is higher than in the control class and is influenced by the use of e-modules based on android mobile as a learning resource in learning activities. The existence of an Android-based e-module that was developed is able to train students to improve their thinking in the problem-solving process. The android-based e-module developed in it examines the topic of environmental pollution in which the chapter is directly related to their surrounding environment so that students can relate what they have learned to the context of life that occurs around them so that the learning activities carried out to make it easier for students to achieve the competencies they need. expected. Selection of the right learning resources can make it easier for students to understand the material being taught (Daryono & Rochmadi, 2020; Rahmatunisa, Sofyan, Daryono, et al., 2022). The problems raised in learning must come from real problems faced by students so that students find it easier to conduct investigations to solve problems (Diana Putra et al., 2019; Rahayu & Kuswanto, 2021).

In learning activities that have been arranged in android-based e-modules, learning activities emphasize group discussion activities, students discuss with predetermined groups to analyze problems in the articles that have been provided in android-based e-modules. With group discussions, each student can express opinions and can exchange ideas with his group to find the right solution to the existing problems. Group discussion activities also provide students with the opportunity to develop thinking skills to improve problem-solving skills through the knowledge or ideas that students have independently and students are given the opportunity to play an active role in searching, studying, and finding their own information to be processed by utilizing e-modules. based on android so that the process of learning activities becomes more in-depth.

While the control class is different from the experimental class, namely learning activities without using e-modules based on android mobile. So that the learning process runs less than optimal because students do not understand the steps they must take in answering and understanding the problems presented in group discussions. As a result, students tend to ask what steps they should take to educators in group discussion activities to solve the problems that have been given. As a result, the time given to the learning process is less than optimal and less efficient and the students in constructing their knowledge independently and in groups are less in-depth so the problem-solving results produced during group discussions are less than optimal when compared to the experimental class.

In this development research, the learning model used in the experimental class is the Flipped classroom model combined with Problem Based Learning) Problem-Based Learning (PBL) can be combined with the flipped classroom model to become a learning model that can be applied in this century (Chua & Islam, 2021; Desai et al., 2018; Judith L Leatherman & Cleveland, 2020). In the flipped classroom learning model, online and offline learning processes are applied. The online stage is carried out before doing classroom learning (offline). At this stage, the teacher shares the Android-based e-module link on the class WhatsApp group to download and study the material and watch learning videos. In the offline stage, students discuss with groups to work on learning activities that have been provided in an Android-based e-module, conclude the results of the discussion and make presentations. At the online stage, students can hone their skills by utilizing android-based e-modules, while at the offline stage students are able to hone problem-solving, group discussion and communication skills which are maximized at the online and offline stages.

The Problem Based Learning (PBL) learning model is a learning model characterized by the availability of challenging contextual problems to be solved by students (Hamid et al., 2017; Suwono et al., 2021; Virgiana & Wasitohadi, 2016). In the Problem Based Learning model, students are given problems by the teacher according to the learning topic, then students discuss in groups to solve the problem-solving. After finishing discussing with the group, students communicate the results of their group discussion by making presentations (Balan et al., 2019; El-Magboub et al., 2016; Farias et al., 2022). This process can train students in terms of communicating in explaining things that have been discussed with the group. Based on the description above, the

researcher combines the flipped classroom learning model combined with PBL using an Android-based e-module which is expected to make students learn independently and continue with an in-depth stage for the problem-solving process.

From the results of the data obtained in this development research, there was an increase in problem-solving abilities using an android-based e-module with a learning model using flipped classroom combined with PBL compared to the control class using the 5M learning model without using an android-based e-module (Chua & Islam, 2021; Guo et al., 2020; Han et al., 2015; Santyasa et al., 2020; Suwono et al., 2021). This is because the flipped classroom learning model combined with PBL using an Android-based e-module can be done by learning independently (online) and deepening the material (offline) (Bani & Masruddin, 2021; Rahayu & Kuswanto, 2021). Online and offline guidance are carried out to overcome students' misconceptions and learning difficulties (Alebrahim & Ku, 2020; Chua & Islam, 2021). In addition, the flipped classroom combined PBL learning model is able to overcome the problems of students' learning difficulties because they are given online and offline learning and tutoring, so that when learning in class, students no longer discuss the material but rather the deepening of the material. The process of deepening the material discussed with the group in the form of solving problems contained in group discussion activities in android-based e-modules (Rahmatunisa, Sofyan, & Rihab Wit Daryono, 2022). Thus, it can be concluded that e-modules Android-based modules combined with the flipped classroom and PBL learning models have an effect on an authentic learning experience so that the problem-solving process of students also increases.

4. CONCLUSION

The mobile android-based e-module is suitable for use in learning environmental pollution material because it meets the assessment aspects based on the results of assessments from material experts, media experts, and biology teachers. E-module based on android mobile is effective in improving the problem-solving ability of students. The increase occurred because the Android-based e-module that was developed examines environmental pollution that is directly related to the surrounding environment and is packaged in applications that can be accessed on students' smartphones so that students feel there is interest and can learn independently so that learning activities become more leverage and achieve competence. which is expected.

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