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Development of Interactive E-Modules of PjBL Models to Improve Understanding of Colloidal Concepts

Rusmansyah[1*], Emelia[1], Atiek Winarti[1], Abdul Hamid[1], Mahdian[1], Arief Ertha Kusuma[2]

[1] Chemistry Education Study Program, Lambung Mangkurat University, Banjarmasin, Indonesia.
[2] PGSD Study Program, Borneo Tarakan University, Tarakan, Indonesia

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Corresponding Author:
Rusmansyah
rusmansyah@ulm.ac.id

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Abstract: Research on the development of learning media for Android-Based Interactive E- modules on colloidal material aims to produce valid, practical and effective learning media. The floating model used is a 4D development model. The trial of the learning media developed was carried out on students of SMAN 1 Kotabaru for the 2020/2021 academic year. The trials carried out were individual trials, small group trials and limited trials. Data collection techniques used validation sheets, readability questionnaires, response questionnaires and test assessments. Data analysis used descriptive analysis. The results showed that the developed media had met the following criteria: (1) Valid, based on a feasibility test by a group of experts with an average of 91.66% (very valid); (2) Practical, based on individual, group readability tests, as well as student and teacher response questionnaires with successive scores of 3.30 (very good); 3.40 (very good); 3.34 (very good) and 3.70 (very good); (3) Effective, based on the results of a limited trial, it can be seen from the average n-gain score of 0.73 (high). Overall, the e-module developed is able to improve students' conceptual understanding skills and as a form of renewal in chemistry learning.

Keywords: Android; Colloid; Interactive E-module; Learning Media; PjBL

Introduction

The COVID-19 pandemic is still a special concern today, and even in Indonesia itself is still a hot topic of conversation. The Indonesian government has also taken various policies such as social distancing, physical distancing, and Large-scale social restrictions (LSSR) to reduce the spread of this virus (Herliandry et al., 2020). The policies issued have an impact on various types of fields, especially the world of education. To be precise, based on the ABC News report, since March 7, 2020, schools and colleges have been closed in more than a dozen countries due to the COVID-19 pandemic (Purwanto et al., 2020). UNESCO also estimates that nearly 900 million students are affected by the closure of educational institutions due to the Covid-19 pandemic (Nicola, et al., 2020).

The closure of educational institutions from preschool and basic education to tertiary education due to the Covid-19 pandemic has had a major impact on the learning process and educational curriculum (Rahmawati & Putri, 2020). The Covid-19 pandemic has forced learning to be done remotely (learning from home) for all elements. This is a challenge for all elements and levels of education to keep the class action during the Covid-19 pandemic by referring to the 2013 curriculum even though learning is online.

This distance learning requires the government to provide alternatives and innovations in the learning process so that education continues and is channeled to students as it should. Students, in this case, must spend time at home studying, discussing, and doing assignments and exams online (Safitri et al., 2020). One of the alternatives given is to use Android as a learning medium. Android is a solution to make students more active in learning (Hadisaputra, Gunawan , & Yustiqvar, 2019).

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Android itself is one application of the 21st-century learning style (Calimag et al., 2014). Android can access video conferencing platforms such as zoom and google meet, like face-to-face learning. The platform allows educators and students to meet and interact virtually with instant messaging facilities for presentation activities (Wiranda & Adri, 2019). Activities during online learning provide much convenience with many platforms that can be accessed via Android and used as a learning tool. It also trains students' independence in learning.

Android provides an open platform for developers to create their applications (Murtiwiyati & Lauren, 2013). Android can be a very interesting opportunity to be used in education as a learning medium to compensate for high mobility so that learning content can be accessed via smartphones anywhere and anytime (Lu'mu, 2017).

According to Bhat and Dutta (2019) smartphone users have grown manifold in the last few decades and are estimated to reach 2.87 billion in 2020. The ease of internet access and increased social media activity are the main causes of the growth of smartphones. In Indonesia alone, Android users until June 2015 reached 65.9% of all smartphone users (Yektyastuti & Ikhsan, 2016). Learning with Android has been widely used, as is the research case that using Android applications by students is very useful in learning and is quite effective for accessing educational information (Juraman, 2014).

The various benefits obtained certainly have obstacles that students in online learning feel. Based on research of Handayani (2020) the obstacles to distance learning are network instability, such as the teacher's voice and teaching materials needing to be in sync, and unable to access the classroom when wi-fi is not connected. Then, the content must be delivered accurately, and the teacher must progress independently without interacting with the students. Many students answered that it took many workouts to concentrate on class for long periods of video conferencing.

Based on the experience of PPL researchers at SMA Negeri 8 Banjarmasin for one month, especially in learning chemistry, both in class XI and XII, the obstacles experienced were almost the same as the explanation above. This makes researchers aware that learning can only sometimes be carried out through video conferences or distance learning service applications. Students especially need learning media that are interesting, easy to understand, and can be read at any time without always depending on the teacher in the learning process. Especially in chemistry subjects which are quite difficult for students to see.

Chemistry is one of the subjects studied in high school. One of the chemicals is colloids. Colloidal system material is closely related to everyday life, so in this case, it is very important to study and understand. However, in learning activities, students only memorize without understanding the material in-depth, so the demands for basic competencies based on the curriculum are not achieved properly. In addition, there is a tendency in the learning process for students need to be more enthusiastic and feel more energized (Eli & Sari, 2018).

Based on the explanation above, researchers are interested in developing an Android-based e-module on colloidal material as a learning resource for students during the Covid-19 pandemic. This is because e-modules have several advantages: (1). More interesting because they can be equipped with multimedia; (2). More interactive; (3). Paperless; and (4). Multiplatform can be used on various devices such as computers and android.

According to Perdana, et al (2017). The module is intended to motivate students to learn independently to increase learning outcomes. However, along with technological developments, modules are not only in the form of print but also electronic or commonly referred to as e-modules. The electronic module (E-module) is an innovation from the print module. It can be accessed via a computer connected to the software, integrated, and supports accessing the E-module (Permatasari, Mudakir, & Fikri, 2017). Interactive e-module teaching materials are teaching materials whose publishing process is in a digital form consisting of text, Figures, or a combination of both (Sutrisno, 2019).

The use of e-modules is an effort to comply with health protocols in the field of education and can be easily accessed via Android (Ilham, Hakim, & Hardian, 2020). In addition, currently, the use of Android among students is increasing rapidly. This is an opportunity for researchers to create an Android-based e-module using the Project-Based Learning (PjBL) model to be used as a learning resource to improve the ability to understand concepts in colloidal material with designs that students easily understand.

Understanding the concept can be interpreted as a person's thought process to process the received teaching materials so that they become meaningful. Concept understanding is an effort to master several subject matters; what is meant is that students not only remember some concepts but can also explain them again in other patterns and apply them to concepts that are in aby cognitive structure of the students themselves (Fitrah, 2017).

The indicator of conceptual understanding is a very important aspect of learning. The indicators for understanding the concept are: (1) restating as a concept; (2) classifying objects according to certain properties (according to the concept); (3) providing examples and non-examples of a concept; (4) presenting concepts in various forms of representation; (5) developing the necessary or sufficient conditions of a concept; (6) use and utilize and choose certain procedures, and (7) apply

concepts in problem-solving (Lestari & Yudhanegara, 2015).

Method

This study is a Research and Development research using a 4D development model. This 4D model was developed by S. Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel in 1974. This study aimed to determine the validity, practicality, and effectiveness of using Android-based E-module learning media using the Project-based Learning model (PjBL) in improving students' conceptual understanding of colloidal material.

Based on the research design or design, there are four stages in this research procedure; the first is the define stage. In simple terms, this stage is the needs analysis stage. Product development refers to the development requirements and analyzes and collects the extent to which development is carried out. This defining stage can be done by analyzing previous research and literature studies. There are five activities at this stage, namely: (1) early-late analysis; (2) student analysis; (3) task analysis; (4) concept analysis; and (5) formulation of learning objectives.

The second stage design. At this stage, the aim is to design learning devices. Four steps must be taken at this stage, namely: (1) preparation of the main reference test; (2) media selection; (3) format selection; and (4) preliminary design.

The third stage is development. This stage aims to produce the final form of the learning device after revisions based on expert input and test data. At this stage, the trial was conducted at SMAN 1 Kotabaru. During the trial process, the researcher noted all the shortcomings and obstacles when using the product. The research design used in this study is pre-experimental in the form of one group pre-test and post-test. This study only used one class that was given treatment in the form of observing the results before learning (O1), being given learning (X), and then observing the results (O2). The last stage in this research procedure is dissemination, which is carried out to promote the development product so that its users, both individuals and groups, can accept data collection techniques carried out in this study used indirect communication techniques, namely through validity test questionnaires, readability questionnaires by students, and student and teacher response questionnaires. Each validator, student, and teacher will provide an assessment on the given sheet. The rating scale used refers to a Likert scale consisting of 4 scores (strongly agree), 3 (agree), 2 (disagree), and 1 (strongly disagree).

The data obtained through the validation questionnaire were analyzed through quantitative analysis techniques. Assessments from experts were analyzed using a formula adapted from Akbar (2013):

$$\text{Media validation value} = \frac{\text{total score given}}{\text{overall score}} \text{ x } 100\% = \cdots \% \quad (1)$$

The validation results whose presentation is known can be matched with the criteria for the level of product validity in Table 1.

Table 1. Validity Criteria

Score	Validation Description	Information
85.00 - 100%	Very valid	No need to revise
70.00 - < 85.00%	Valid	No need to revise
50.00 - < 70.00%	Not valid	Minor revision
01.00 - < 50.00%	Invalid	Big revision

(Akbar, 2013)

The data from the questionnaire results of the student readability test, student responses, and teacher responses were analyzed to determine the practicality of the learning media developed. Scores of student responses to the studied learning media can use the criteria presented in Table 2.

Table 2. Student Response Criteria

Average score	Information
> 3.25 – 4.00	Very good
> 2.50 – 3.25	Well
> 1.75 – 2.50	Not good
1.00– 1.75	Not very good

(Widoyoko, 2020)

Result and Discussion

The research was carried out at SMAN 1 Kotabaru with research subjects, namely students of class XII IPA 1, XII IPA 2, and XII IPA 3. By the research objectives, this section presents the results of the developed products' validity, practicality, and effectiveness tests. Based on the development procedures that have been described in developing this Android-Based E-module learning media, the results are:

Development Results

The product produced in this development study is an Android-based interactive E-module learning media using the Project-Based Learning (PjBL) learning model on colloidal material. E-module is a learning media in the form of a flipbook, so it is more innovative because in addition to containing learning material, it also contains Figures, videos, and audio containing music that is packaged in one file so that it can be read by electronic devices such as computers, laptops, and androids.

This E-module is designed systematically with material that is easy to understand and integrates the

Project Based Learning (PjBL) learning model in the form of project assignments in groups for students. This e-module aims to help students learn independently at home, especially during a pandemic like now; learning seems monotonous due to the limitations of the activities carried out, as well as unpredictable network instability.

Assistance using the Project-Based Learning (PjBL) learning model is expected to give a new color to learning to encourage student's enthusiasm for learning and increase the ability to understand concepts in understanding the material given, especially in the colloid chapter chemistry lesson.

The Project-Based Learning (PjBL) learning model was chosen to be integrated into this e-module because it is one of the learning models referred to based on the Circular of the Minister of Education and Culture no. 4 of 2020. Project-Based Learning (PjBL) is designed to be used on complex problems that are required students to conduct investigations and understand them. PjBL can be seen as learning that can encourage students to build knowledge and skills through direct experience (Wahyu, 2016).

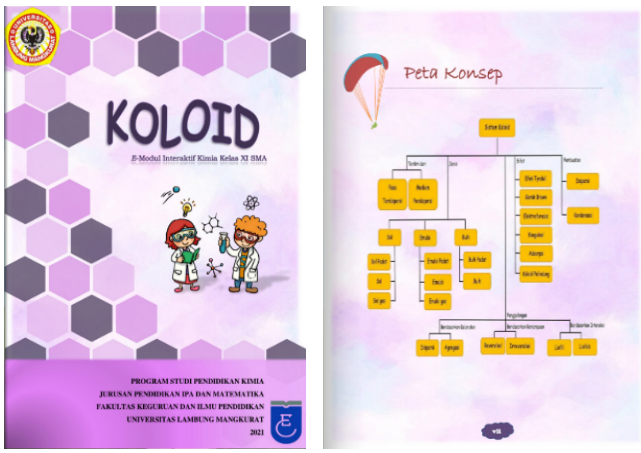


Figure 1. Android-Based Interactive E-Module Display Design

The advantage of this e-module itself is that it is an interactive learning media that can be accessed easily through the students' androids; with this e-module, it is hoped that the learning process that takes place during learning does not depend on space and time, especially the e-module developed has been designed to the individual (Agustia & Fauzi, 2019). As stated by Jazuli et al. (2018), Another use of e-modules is that they can maximize flexibility in learning, and students can use them repeatedly. Students who are absent due to illness and travel can access learning anytime without being bound by time. Figure 1 shows the design of the Android-based E-module learning media display that has been developed.

Validity Test Results

The learning media that will be developed is validated by the validator before the trial is carried out. It aims to determine the validity of the developed media. The intended validators consisted of one lecturer of Education Technology at FKIP ULM Banjarmasin, three lecturers of Chemistry Education at FKIP ULM Banjarmasin, and one chemistry teacher at SMAN 1 Kotabaru. The feasibility of the Android-based E-module learning media can be known through an assessment carried out by the validator using a validation sheet that refers to four aspects of the assessment's feasibility: content, presentation, language, and media.

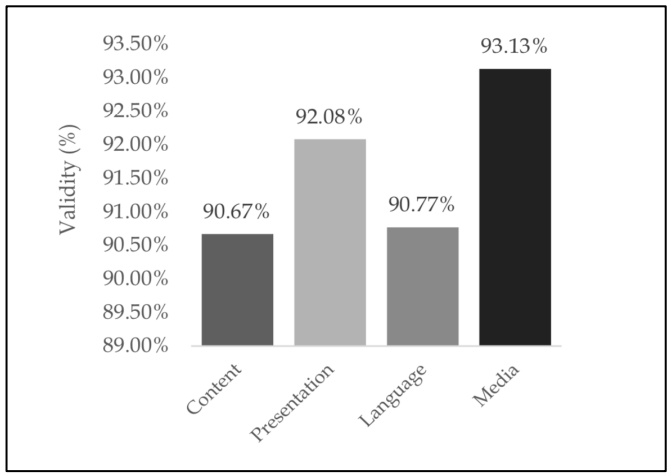


Figure 2. Validity Test Results

The percentage of validation by validators on the feasibility of content, presentation, language, and media for android-based e-module validation is 90.67; 92.08%; 90.77%; and 93.13%. The percentage results can thus be categorized in a very valid category so that the Android-Based E-module learning media is feasible to use without revision. This is in line with and supported by several e-module research results that have been developed by several researchers obtaining a content feasibility percentage of 77.8% from Ningsih, Ruhiat, & Saefullah (2020) research, presentation feasibility of 91% of Wulandari (2020) research, and language and media feasibility of 87% and 77% % of Husnulwati et al. (2019) research with a valid category.

Content Feasibility Aspect

The content feasibility aspect contains four assessment indicators. The indicators for assessing the content feasibility aspect can be seen in Table 3.

Table 3. Content Feasibility Aspect Assessment Indicators

Rating Indicator	Rating Points
The suitability of the material with the content	Material equipment Depth of material
Material Accuracy	Concept and definition accuracy Sample accuracy Question accuracy Accuracy of drawings, diagrams, and illustrations
Supporting Learning Materials	Reasoning Linkages Communication Application The material presented in the e-interesting module Encouraging to seek further information
Update of Material	The suitability of the material with the development of science Actual drawings, diagrams, and illustrations Library updates

The results of the validator's assessment of the e-module on the aspect of content feasibility are presented in Figure 3.

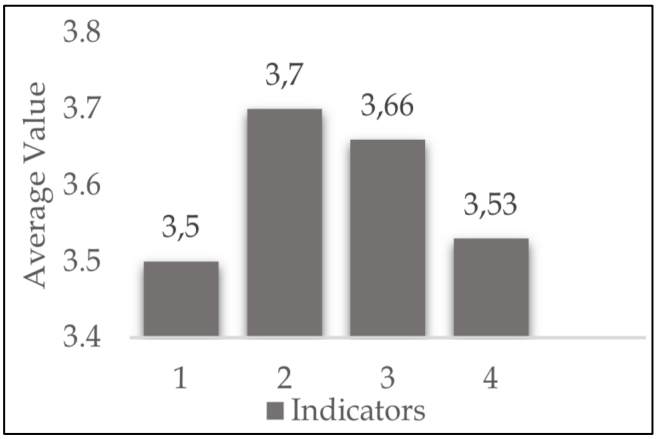


Figure 3. Results of Validator Assessment of Android-Based E-modules on Content Feasibility Aspects

Indicator Description:
1. The suitability of the material with the content
2. Material accuracy
3. Supporting learning materials
4. Material updates

Based on the results of the validator's assessment for the content feasibility aspect, it has a high average value for each assessment item; thus, the content feasibility aspect for the android-based e-module means that it is good, so in this aspect, there are no things that need to be revised because it has been declared feasible. The percentage of content eligibility obtained for android-based e-modules is 90.67%, with a very valid category.

Aspects of Feasibility of Presentation

The presentation feasibility aspect contains four assessment indicators. The indicators for assessing the content feasibility aspect can be seen in Table 4.

Table 4. Indicators of Assessment of Feasibility Aspects of Presentation

Rating Indicator	Rating Points
Presentation Techniques	Systematic consistency of presentation in e-modules
Presentation Support	The presentation is presented sequentially. Foreword Characteristics of e-module Conclusion summary Table of contents References Answer key
Presentation of Learning	The presentation of learning involves students.
Completeness of Presentation	Introduction part Contents section Cover part

The results of the validator's assessment of the e-module on the presentation feasibility aspect are presented in Figure 4.

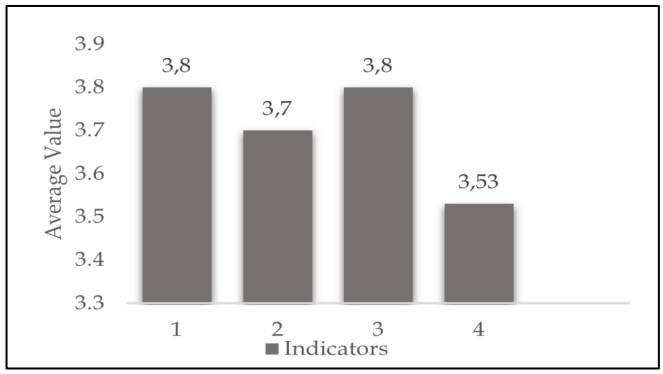


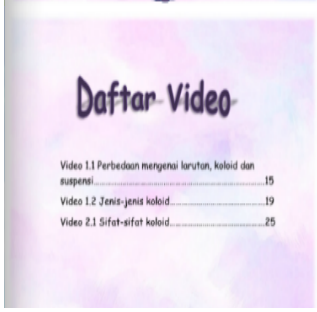
Figure 4. The results of the Validator's Assessment of Android-Based E-modules on the Feasibility Aspect of Presentation

Indicator description:
1. Presentation technique
2. Serving support
3. Learning Presentation
4. Serving equipment

Indicators 1, 2, 3, and 4 scored 3.8; 3.7; 3.8; and 3.53, with a very good category. Based on the validator's suggestions, for the sake of completeness and perfection of the e-module, it is necessary to revise it by adding a

summary of the material, a list of videos, and an answer key. The display of the e-module before and after the revision is presented in Table 5.

Table 5. Display Before and After Revision of Indicators 2 Aspects of Feasibility of Presentation

Before Revision	After Revision
No material summary	
No answer key	
No video list	

Based on the validator's assessment results for the presentation feasibility aspect, the percentage value of the presentation feasibility for android-based e-modules is 92.08%, with a very valid category.

Language Feasibility Aspect

The language feasibility aspect comprises six assessment indicators, each containing assessment points. The indicators for assessing the content feasibility aspect can be seen in Table 6.

Table 6. Language Feasibility Aspect Assessment Indicators

Rating Indicator	Rating Points
Straightforward	Correct sentence structure
	Sentence effectiveness
	Term standard
Communicative	Information readability
	The accuracy of the use of language rules
Dialogic and Interactive	Ability to motivate messages or information
	Ability to encourage analytical thinking
Conformity with the level of development of students	The suitability of the intellectual development of students
Coherence and coherence of the flow of thought	Conformity with the level of emotional development of students
	Coherence and integration between learning activities
	Coherence and coherence between paragraphs
Use of terms, symbols, or icons	Consistency in the use of terms
	Consistency in the use of icons or symbols

The results of the validator's assessment of the e-module on the language feasibility aspect are presented in Figure 5.

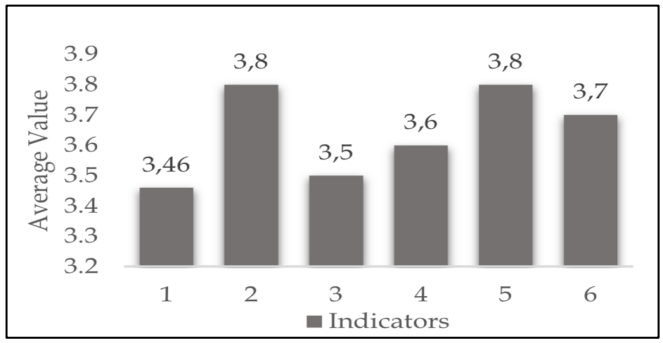


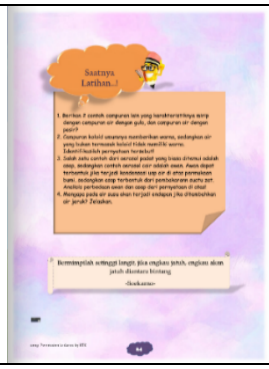
Figure 5. Results of Validator Assessment of Android-Based E-module on Language Feasibility Aspects

Indicator description:
1. Straightforward
2. Communicative
3. Dialogic and interactive
4. Conformity to the level of development of students
5. Coherence and coherence of the flow of thought
6. Use of terms, symbols, or icons

Indicators 1, 2, 3, 4, 5, and 6 scored 3.46; 3.8; 3.5; 3,6; 3.8; and 3.7, which means it is good. According to the validator, some elements must be improved in the third indicator. Based on the validator's suggestion, the third indicator needs to be revised by adding HOTS practice

questions. The display of the e-module before and after the revision is presented in Table 7.

Table 7. Display Before and After Revision of Indicators 3 Aspects of Language Feasibility

Before revision	After revision
No HOTS	

Based on the validator's assessment results for the language feasibility aspect, the percentage value of language eligibility for android-based e-modules is 90.77%, with a very valid category.

Media Feasibility Aspect

The media feasibility aspect comprises two assessment indicators, each containing assessment points. The indicators for assessing the content feasibility aspect can be seen in Table 8.

Table 8. Media Feasibility Aspect Assessment Indicators

Rating Indicator	Rating Points
Display and content	Color composition
	Illustration or picture
	Letter
	Layout (layout)
	Videos
	Instructions for use
Characteristics	Media use
	Attractiveness

The results of the validator's assessment of the e-module on the media feasibility aspect are presented in Figure 6.

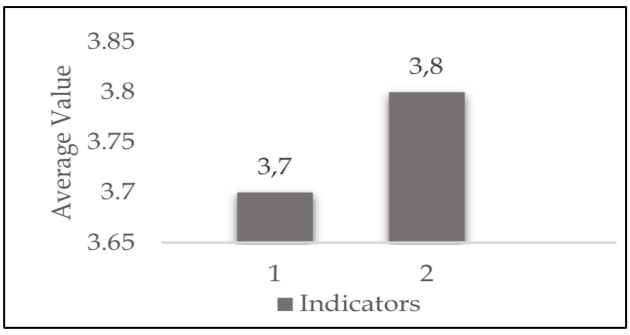
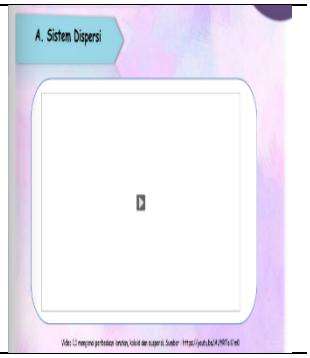


Figure 6. Results of Validator Assessment of Android-Based E-modules on Media Eligibility Aspects

Indicator description:
Display and content
Characteristics

The first and second indicators respectively scored 3.7 and 3.8, which means they are very good. However, the validator gives suggestions that there is a need for revision, namely by adding information to the video. The display of the e-module before and after the revision is presented in Table 9. Based on the validator's assessment results for the media feasibility aspect, the percentage value of media eligibility for android-based e-modules is 93.13%, with a very valid category.

Table 9. E-Module Display After Added Video Description

Before revision	After revision
No video description	

Practicality Test Results

The product validated by the validator is then tested for practicality by providing response questionnaires to students. This aims to see the practicality of the developed Android-based E-module learning media. The practicality of the Android-Based E-module learning media was analyzed through three questionnaires: a readability questionnaire, a student response questionnaire, and a teacher response questionnaire. The results of the practicality test can be seen in Figure 7.

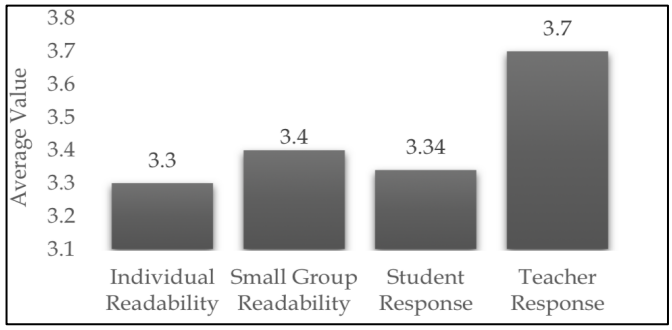


Figure 7. Practicality Test Results

Readability of Android-Based Interactive E-Module Learning Media

This trial aims to see the readability of the Android-Based E-module learning media in assessing the

practicality of the product being developed. Suggestions from students will be used to revise the learning product to be tested at the next stage. The readability test of the Android-Based E-module learning media was carried out in two stages; the first stage was through individual trials on three students of class XII IPA 3. Then continued the second stage, namely small group trials on nine students of class XII IPA 1 SMAN 1 K/otabaru Academic Year 2020/2021. The average values obtained in individual and small group trials are 3.3 and 3.4, respectively, in the very good category.

Student Response

The response questionnaire was given in a limited trial to 33 students of class XII IPA 2 SMAN 1 Kotabaru for the 2020/2021 academic year. This aims to determine students' responses to the use of learning media based on Android-based E-modules that were developed. Student response is important because it determines the feasibility and interest related to the device that has been developed (Hamzah & Mentari , 2017). This response questionnaire contains statement items and is given to students after doing the post-test. Based on the study's results, the average student response value was 3.34, included in the very good category.

A positive response of 3.34 (very good) indicates that students prefer the Android-Based E-module media as a practical learning medium. These results, as a whole, certainly cannot be separated from the influence of the modules used, where the modules that have been developed can help students more easily understand the material provided (Khayati, Sujadi, & Saputro, 2016).

Learning media that is considered valid and practical is used as one of the media that can help the chemistry learning process if it meets the criteria of validity and practicality. In line with the opinion (Sukoco, 2014) that learning media is a tool that can be used to convey a learning message.

Teacher's Response

The teacher's response using the Android-Based E-module learning media was measured using a response questionnaire. The results of the teacher's response to the Android-Based E-module learning media in the limited trial showed the average value obtained is 3.7, which is included in the very good criteria.

Effectiveness Test Results

After passing the individual and small group trials, a limited trial was conducted. This limited trial was conducted on 33 students of class XII IPA 2 SMAN 1 Kotabaru, which aims to test the effectiveness of the learning media developed. The effectiveness of the Android-Based E-module learning media is seen based on the assessment of the test, which is in the form of a test in the form of learning outcomes in the realm of knowledge.

Cognitive/Knowledge Learning Outcomes

The effectiveness of developing Android-based learning media for E-modules is measured by the ability of students to complete the given cognitive learning outcomes test. The results of the cognitive test carried out by students were analyzed through the calculation of N-gain in a limited trial. Learning media based on Android E-module is said to be effective if there is a change in the value of students' cognitive learning outcomes during the pre-test and post-test. The average learning outcomes of knowledge from a limited trial conducted in class XII IPA 2 SMAN 1 Kotabaru semester 1 of the 2020/2021 Academic Year are presented in Figure 8.

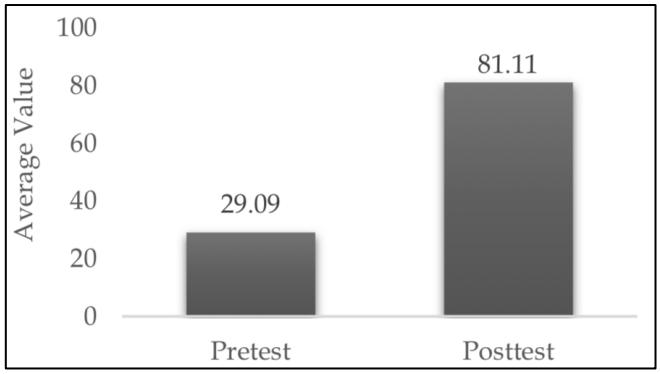


Figure 8. Average Pretest and Posttest scores

Based on the results of the pretest and post-test, the criteria for understanding students' concepts can be seen in Table 10.

Table 10. Concept Understanding Criteria

Criteria	Percentage	*Pretest*	*Post-Test*
Very high	80 – 100	0	23
Tall	60 – 79	1	10
Currently	40 – 59	6	0
Low	20 – 39	20	0
Very low	0 - 19	6	0
Amount		33	33

Based on the research results, the Android-Based E-module learning media can improve students' conceptual understanding. This is marked by increased student learning outcomes seen in the results of limited trials, with an average N-gain value of 0.73 in the high category. Thus, this Android-Based E-module learning media can be stated as an effective learning medium.

During the learning process, students read the material and worked on group project assignments related to the colloid system. It is intended that students do not feel monotonous learning; easy to understand the concept of the material provided, and through the

projects given, students can see and learn directly about the material being studied. This group project task can be carried out because the Kotabaru area at that time was in the green zone, so students could meet each other to work on joint projects.

E-module is an independent learning medium because it has a self-study guide. This differs from the usual module; this e-module contains material in word or pdf form and can also display a video explanation of the material, allowing users to learn more actively (Fajaryati et al., 2016). This Android-based interactive e-module is an effective learning medium. In line with the opinion of Pradilasari, Gani, & Khaldun (2019) that with the media, the material presented will be more readily understood by students. Learning objectives will also be achieved by using effective media.

The purpose of the Android-based interactive e-module learning media used in this research is to improve students' conceptual understanding skills and provide new colors for online learning during the COVID-19 pandemic. So, in this case, the Android-based interactive e-module learning media is expected to provide motivation and enthusiasm for learning to students. This Android-based e-module has a unique, attractive design that is easy for students to operate and understand. Materials and practice questions are by KD and learning objectives. Students can learn at any time because it is practical to use.

The results of the validity and effectiveness of using Android-based interactive e-module learning media are in line with research that has been done by Zahra, Handayani, & Handayani (2020) that the Android-based e-module learning media is very suitable to be used as a learning medium, then Laili et al. (2019) and Priatna, Putrama, & Divayana (2017) in his research stated that the e-module Project Based Learning is effective in improving student learning outcomes and is worthy of being used as a learning resource. In addition, based on Murod et al. (2021) research, Android-based interactive e-modules are quite effective in increasing students' understanding of concepts.

The positive results regarding this Android-based interactive e-module prove that this media can improve learning outcomes which has an impact on increasing students' conceptual understanding abilities. However, these results must be integrated with integrating learning in an environment that can improve student learning outcomes. In addition, integration with technology is also believed to provide a renewal in learning so that learning becomes more meaningful and easier for students to follow (Nawidi, 2019).

Conclusion

Interactive E-module learning media based on Android on colloidal material are very valid for use in learning with a media validation score through individual and small group readability tests with an average of 3.3 and 3.4 in the very good category. This media also fulfills practical aspects through readability tests on students and teachers with average scores of 3.34 and 3.7. This media also fulfills the effective aspect marked by increased student learning outcomes as a benchmark in improving the ability to understand concepts with an N-gain value of 0.73.

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