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Development of Ecosystem *E-Module* Based on *Inquiry Learning* to Improve Students' Learning Outcomes

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Abstract

The ICTdevelopment has driven changes in the learning by utilizing the latest Android based innovative teaching. Learning innovations need to be developed by mobile learning are e-module. This would analyze the feasibility and student learning outcomes using the e-module ecosystem based on inquiry learning. The subjects of this study were students of X IPA 1, X IPA 2, X IPA 3, and X IPA 4 in SMA Negeri 1 Bandar. Research and Development (R&D) done following identification of potential and problems, data collection, design, validation, revision I, small-scale trials, revision II, large scale trials, final revisions and production. The data analysis done by administering media and material validity questionnaires, as well as practicality questionnaires on small and large-scale tests. Data was analysed by descriptive percentages. The results showed that the e-module was feasible as a teaching material (91.25 % for media) and (71.25% for material). Small-scale trials gave 78% practicality and completeness of 86%. The large-scale trial based on teacher responses of 100% and student responses of 99.02% (very good). The students' completeness in the large-scale test was 89.63% . It is proven that the developed e-module can be applied and students have fulfilled the classical completeness (≥85%).

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PRELIMINARY

The development of technology, information, and communication has driven changes in various sectors including the learning process, especially the 2013 Curriculum. Regulation of the Minister of Education, Culture, Research and Technology (Permendikbud) number 5 of 2022 concerning graduate competency standards in early childhood education, level basic education, and secondary education level is about the unity of attitudes, skills, and knowledge that shows the achievement of student's abilities and learning outcomes at the end of the education level. Teachers as teaching staff are required to develop learning tools by utilizing technology that can stimulate independent learning. Quality learning tools can improve students' learning activities and creative and critical thinking (Evawani *et al.*, 2013) .

The development of information technology is used by educational institutions to make learning materials. Materials (tools or text and information) that are structured to support lesson plans that can assist teachers in the learning process based on the curriculum are called teaching materials (Prastowo, 2012). The learning process needs to be supported by the development of teaching materials, this can be seen from the increased learning achievement and motivation as well as student completeness (Kurniawati *et al* ., 2014) .

Based on the teacher and students interviews at SMA Negeri 1 Bandar, it was shown that 95% of 10th graders already have *an android smartphone.* The development of information technology makes students interested in utilizing IT (Information Technology) as learning materials in the form of modules. The results of observations made at SMA Negeri 1 Bandar show that the learning materials provided at school are in the form of textbooks and worksheets, but not all learning materials can help students in the learning process. Many students are lazy to read learning materials because the visuals of textbooks and LKS are not attractive, the language is difficult to understand, and the pictures are not colored, especially in Ecosystem material. Class X students find it difficult to understand material about interactions between ecosystem components and pyramids because the material is broad, the pictures are not colored, and student's interest in reading is lacking. The problem with the learning process at SMA Negeri 1 Bandar, especially ecosystem material, is that the teaching materials used are limited and less interesting in the form of textbooks, and worksheets and have not utilized technology in teaching materials.

Ecosystem material is the subject matter of biology semester II class X which has a fairly broad object learning area. The scope of the material is ecosystem components, interactions between ecosystem components, ecological pyramids, and productivity. Ecosystems study the flow of energy and biogeochemical cycles. So we need teaching materials that can explain in communicative language and display colorful pictures or videos so students can easily understand ecosystem material.

Technological advances have provided a variety of learning materials with the latest innovations or commonly known as *mobile learning. Mobile learning* can be applied to the learning process using *an Android smartphone.* The use of *mobile learning* technology in science and technology can assist educators in developing their abilities in the field of science and technology (Crompton *et al* ., 2016) . Learning innovations developed by utilizing *mobile learning* are *e-modules. E-module* is teaching material in electronic form that can be used on *smartphones* and laptops. *The e-module* is equipped with clear videos, animations, and pictures.

E-module is an ICT-based module. The advantages *of e-modules* compared to print modules are the interactive nature of *e-modules* displaying images, videos, animations, and are equipped with formative tests or quizzes that allow automatic feedback and facilitate navigation. Electronic media can assist students in presenting reliable and interesting data, facilitating data translation, increasing understanding, and condensing information (Asnawir & Usman, 2002). *E-modules* need to be developed to provide opportunities for students to learn how to get facts, concepts, and principles through scientific processes (Budiarti, 2016) . Students need to practice developing a scientific attitude and science, which allows for a good process of understanding the material, students do not only learn by reading then memorizing the material.

Based on Permendikbud Number 16 of 2022 concerning process standards in early childhood education, elementary and secondary education levels that the learning strategy for achieving learning goals is to provide quality learning experiences, namely giving students opportunities to apply a material to real problems or contexts, encouraging student interaction and active participation, optimizing the use of available resources in the environment and using information and communication technology devices. The learning process uses learning approaches or methods that are appropriate to the characteristics of students and subjects. The approaches and methods recommended in the standard process are scientific approaches, inquiry, problem-based learning, and project-based learning.

Process standards relate to activities between students and teachers and their environment during the learning process. The low learning process in biology at SMA N 1 Bandar is influenced by the less optimal learning process that takes place in class. The cause of the learning process that is not optimal is that students are still focused on the teacher and the teacher still prioritizes the product compared to the process, resulting in students tending to passively only accept the material being taught and tend to be silent when the teacher asks questions. Therefore, it is necessary to develop *e-modules* based on *inquiry learning* which have not been implemented by teachers in classes with biology material. Inquiry-based *learning* allows students to describe objects or events, ask questions, gain knowledge, make explanations of natural phenomena, and communicate ideas (Holmes, 2013) . Discovery-based learning can improve students' critical thinking skills and provide learning experiences to students like a scientist through the scientific method (Kızılaslan *et al* ., 2012) .

Through *inquiry-based learning,* students gain the ability to use tools and resources to learn while studying subject matter and acquire basic skills (Kuhlthau *et al* ., 2007) . The application of *inquiry learning-based learning methods* for biology can improve students' understanding of concepts, to improve learning outcomes. Inquiry-based learning can increase students' self-confidence.

Based on the explanation above, to improve student learning outcomes, teaching materials are needed that are by following per under technological developments by following per under the 2013 Curriculum. The solution is to develop an *e-module* ecosystem that is integrated with the *inquiry learning lmodel. E-module* is a way of organizing teaching materials related to the sequence of presentation of teaching materials and showing students the relevance of facts, concepts, procedures, and principles contained in teaching materials. Inquiry-based *learning e-module* acts as a link between student knowledge and the object studied through the activities in the *e-module* and allows students to master the subject matter unit before moving on to the next unit (Prastowo, 2012; Sungkono, 2003).

Based on the statements above, SMA N 1 Bandar supports the development of an *inquiry*-based ecosystem *e-module learning* for class X because class X students have supporting facilities such as *smartphones.* Students and teachers will be provided with a web to access ecosystem learning materials. The accessed *e-module* supports distance learning. Therefore, it is necessary to develop an *inquiry*-based ecosystem *e-module learning* which contains writing, pictures, and videos. The development of *e-modules* is expected to provide interesting and interactive teaching materials, as well as facilitate direct and indirect learning for teachers and students, and enable effective learning to improve academic abilities and student learning outcomes.

RESEARCH METHODS

This research was conducted at Bandar 1 Public High School in the Even Semester of the 2021/2022 academic year. This research used the *Research and Development* (R&D) model. The research design used in the effectiveness test was *pre-experimental* in the form of a *one-shot case study.* Data were collected by interviews, filling out questionnaires, tests, and documentation. The feasibility of the module was from media expert validation, material expert validation, student response questionnaire, and teacher response questionnaire. Data on cognitive learning outcomes were obtained from student achievement in basic competencies 3.10 and 4.10 which included test scores, independent tests, observations, and presenting

works in the form of charts.

RESULTS AND DISCUSSION

The results obtained in this study are *e - module* feasibility validity, small-scale tests, and large-scale tests. Feasibility data were validated by media and material validators, small-scale tests are obtained from student readability questionnaires on *e-modules* and learning outcomes, and large-scale *e-module tests are* obtained from student learning outcomes through *test scores*, independent tests, observations, and making works charta, student response questionnaire, and teacher response questionnaire.

E-Module Eligibility

e-module eligibility assessed by media experts and material experts. Analysis of the final *e-module feasibility results* by media experts and material experts can be seen in Table 1.

Table 1. The Media Feasibility by Media and Material Experts

Validators	Rated aspect	Percentage (%)	Eligibility Criteria
Media Expert	Software engineering	95	Very Worth it
	Ease of Use	87.5	Very Worth it
	Benefits	87.5	Very Worth it
	graphics	92.8	Very Worth it
	Average	91.2	Very Worth it
Material Expert	Content Eligibility	66.7	Worthy
	language	75	Worthy
	Presentation	75	Worthy
	Average	71.2	Worthy

Based on Table 1 it is known that the process of assessing the characteristics of the *e-module* ecosystem based on *inquiry learning* by the media expert validator obtained a score of 73 out of a total score of 80 with a percentage of 91.25%, a very valid category because the score from media experts obtained ≥ 62.50%. The results of the media validator's assessment gave a score of 3 on 7 aspects and gave a maximum score of 4 on 13 aspects. Aspects that get a score of 3 are aspects of layout accuracy, ease of finding *e-module pages*, instructions for using the *e-module*, ease of use of the *e-module*, text, and images of the *e-module*, *back text,* and intonation *of the e-module.* Suggestions from media experts are "preface" in the *e-module* is replaced with "preface", the word concept map be replaced with "material map" and the self-practice questions are too many narrations lacking pictures.

Based on Table 1 the results obtained from the validation of the material expert get a score of 57 out of a total score of 80 with a percentage of 71 .25 % which is included in the valid category so it is suitable for use by improving *the e-module* to make it better, validation of material experts is said to be feasible because the percentage is ≥ 62, 50%. Based on the results of the material validator's assessment of the assessment aspects, a score of 3 was obtained. The advice given by the material expert lecturers is to improve *the e-module* to make it better because in principle teaching materials are good enough to be used for research, but it would be better if revisions were made to the material.

In the assessment of the media and material the score shows that *the e-module* is very suitable as teaching material because there is no minimum score of 1or 2. The e *-module* presents illustrations and charts that make it easier for students to learn *the e-module*, this is by following per under the statement (Sanjaya, 2014) states that charts on teaching materials aim to present learning messages by combining elements of writing, images, and photos into a meaningful whole to simplify complex learning materials so that they are

easy to understand. The ecosystem material presented in the *e-module* is suitable for use in the learning process because the material presented has been adapted to the needs of students according to the learning objectives and basic competencies in the 2013 curriculum on ecosystem material. In the 2013 curriculum, the learning process is designed to enable students to acquire certain competencies, whereas in the ecosystem material students are focused on being able to have analytical skills.

Small Scale Test Results

Small-scale tests were carried out to obtain student responses and student learning outcomes as an improvement to *the e-module* ecosystem based on *inquiry learning* in terms of the appearance and readability *of the e-module* before using large-scale tests. A small-scale test was conducted on 36 students of class X IPA 4. The instrument used was an *e-module* that had been validated and a small-scale test sheet was given to students. The results of the student response questionnaire can be seen in table 2.

Table 2. Results of Small Scale-Students' Responses to *the E-Module*

Percentage	Criteria	Amount
81.25% < score ≤ 100%	Very good	14
62.50% < score ≤ 81.25%	Well	22
43.75% < score ≤ 62.50%	Pretty good	-
25.00% < score ≤ 43.75%%	Not good	-

In the implementation of the *e-module* before it is used for the learning process, a small-scale test was done on students in class X IPA 4. This small-scale test was carried out using a questionnaire and student learning outcomes. The results of the small-scale test student responses can be seen in Table 2. It is known that the results of the small-scale trial of the *e-module* received a percentage of 78%. Overall, students responded well to the existence of the *e-module* as teaching material. *The e-module* is said to be feasible because the percentage of students' readability of the *e-module* is ≥62.50 %. Viewed from the aspect of interest, students were very interested in the appearance *of the e-module,* learning was fun and not boring, and the illustrations contained in *the e-module are* easy to understand. Learning using *e-modules* attractsed students' attention with multimedia displays that can be used in distance learning. *E-modules* are presented in an attractive appearance, colors and designs (text, images, videos) are presented clearly and not exaggerated. Sungkono, *et al.* (2003) explained that the clarity of concepts and descriptions as well as the attractiveness of the presentation are the most important things when making computer-based teaching materials. The language that is straightforward, not interpretive will be easily understood by students. Clear images are highly recommended when developing computer-based teaching materials. *The e-module* presents material by visualizing real objects through pictures and videos so that students can easily understand the contents of the material. This is by following per under Niswa (2012) who said pictures can enhance students' experience and understanding, can be understood clearly and not easily forgotten. According to James W. Brown (Sudjana & Rivai, 2013), effective learning to increase students' interest in learning is to use pictorial illustrations.

Table 3. Student Learning Outcomes on a Small Scale

No	Indicator	Amount
1.	The number of students	36
2.	Complete	31
3.	Not Completed	5
	Percentage of Classical Mastery	86%

The learning outcomes of the small-scale test students are presented in Table 3, students are said

to pass if the results are ≥75 based on the minimum biology completeness criteria at SMA Negeri 1 Bandar. Student learning outcomes in the small-scale test obtained a classical completeness percentage of 86% of 36 students with 5 students getting scores below 75. The number of students based on classical completeness X IPA 4 met the criteria, namely ≥85% so *the e-module was* effectively used as a learning resource students.

Large-Scale Test Results

Large-scale tests were carried out to obtain data on the application of the developed *e-module*. Large-scale tests were measured using student learning outcomes in the form of *tests*, independent tests, student activities, and chart work, as well as teacher and student responses regarding *the e-module* used.

The implementation stage or application of *inquiry learning*-based ecosystem *e-module products* as a result of development aims to obtain data on the feasibility and effectiveness *of e-modules* as teaching materials. The *e-module* implementation stage is carried out when learning ecosystem material. Large-scale trials aim to obtain data on the effectiveness of *inquir* -based ecosystem *e-modules learning* that is developed towards the learning process. *e-module* is said to be effective if the percentage of classical completeness of students with KKM 75 reaches ≥ 85%. Large-scale trials were carried out in classes X IPA 1, X IPA 2, and X IPA 3 at SMA Negeri 1 Bandar for the 2021/2022 academic year.

Data on the effectiveness of the *e-module* ecosystem based on *inquiry learning is* obtained from student learning outcomes. Student learning outcomes are obtained from *test scores*, independent tests, student activities, and chart work. The test questions used consisted of 25 multiple-choice questions. Data on student learning outcomes is presented in Table 4.

Table 4 . Results of Students' Classical Mastery on Large-Scale Tests

No	Indicator	Amount		
		X IPA 1	**XIPA 2**	**XIPA 3**
1.	The number of students	36	35	36
2.	complete	33	31	32
3.	Not Completed	3	4	4
Percentage of Classical Mastery		**91.6%**	**88.5%**	**88.8%**
Percentage of Classical Mastery of the three classes			**89.6%**	

The application of the ecosystem *e-module* was carried out at SMA Negeri 1 Bandar in ecosystem learning in class X IPA 1, X IPA 2, and X IPA 3, totaling 36 students, 35 students, and 36 students in each class. Data on learning outcomes were obtained from *test scores*, independent tests, student activities, and chart work. Based on the results of the scores in Table 4 it is known that the classical completeness obtained by class X IPA 1, X IPA 2, and X IPA 3 is 91.6%, 88.5%, and 88.8% respectively with the percentage of classical completeness of the three classes is 89.6%, so that the ecosystem *e-module* is considered effective in terms of classical completeness, because the percentage of classical completeness produced is ≥ 85%.

Based on the learning outcomes of class X IPA 1 students who did not complete their studies, there were 3 students. Factors in students' incompleteness include students not doing assignments such as making chart works and student test scores that are classified as "passed or not passed". In class X IPA 2 students who did not pass their studies there were 4 students, the factors causing the fail was not doing the chart work and low test scores. In class X IPA 3, 4 students were failed, the factors that caused the fail were skipping *chart work*, the scores were being under the KKM and there were several children who did not take the *test* and did not perform the observation activities optimally. Completeness of learning outcomes is supported by *inquiry-based learning*, learning that involves students to be actively involved in discovering concepts from phenomena that exist in the environment. *Inquiry learning* is carried out because

this learning model refers to investigative activities and explains the relationship between objects and events. This form of *inquiry learning* is in the form of motivating students to investigate existing problems by using scientific skills. This is following Azizmalayeri *et al* (2012), who stated that *inquiry learning* emphasizes student collaboration to solve problems in groups and build knowledge independently. Inquiry learning can help students be more independent and responsible.

The *inquiry learning-based e-module* ecosystem learning process cannot be separated from the constraints that had been carried out during the research. Constraints occured before the teaching and learning process. Before learning begins, students were given *the e-module* via the *share link* in the *WhatsApp* class group, to open *the e-module* requires a good internet network, constrained by an unstable *wifi connection due to the location of the school which is in a mountainous area which causes connection interuption.* During learning, not all students listened to the teacher's instructions in implementing *the e-module* or when the teacher asked students to open questions on exercises. Teaching materials in the form of *e-modules* using *Android* are independent so that students can learn at their own learning pace. Mckendry & Boyd (2012) stated that learning in high school and university students shows they have a responsibility for themselves in obtaining the knowledge needed in their way. Independent learning cannot be separated from the teacher's responsibility to guide students in carrying out the learning process.

Furthermore, the learning process was carried out by utilizing *the e-module* ecosystem based on *inquiry learning* as teaching materials. At the end of ecosystem learning, students had tests as the learning outcomes after implementing the ecosystem material *e-module.* Based on score of the tests and exercises resulting in classical mastery scores, the *e-module* is effectively used for teaching materials and used the *kvisoft flipbook maker application feature* which could make teaching materials interesting, the development of *e-module* ecosystems based on *inquiry learning* made students more interactive where students could observe videos in the *e-module,* students conduct lots of discussions, make observations, observe pictures, and ask questions. This is in line with Sakat *et al* (2012) and Yektyastuti & Ikhsan (2016) that the learning process by utilizing technology-based teaching materials will have a positive influence on improving students' academic abilities. By following per under the research of Wulandari *et al* (2021) which states that *e-module* can increase student motivation and influence good learning outcomes by 30.80%. The learning outcomes and responses of teachers and students in large-scale tests show that *e-modules* can be used as teaching materials suitable for use by students during teaching and learning activities independently and effectively.

After analyzing the learning outcomes, students filled out a response questionnaire to the *e-module* needed to find out the student's response after learning using *the e-module* ecosystem based on *inquiry learning.* The results of the analysis of student responses to *the e-module* on a large scale, obtained responses of 34 students with an average good criterion by class X IPA 1, 34 students with an average good criterion for class X IPA 2, 35 students with an average good criterion by class X IPA 3. The results of the recapitulation of student responses to *the e-module* ecosystem based on *inquiry learning* are presented in Table 5.

Table 5. Results of Student Responses to Large-Scale *E-module*

Percentage	**Criteria**	**Total Percentage**	
81.25% < score ≤ 100%	Very good	24	23.07%
62.50% < score ≤ 81.25%	Well	71	68.26%
43.75% < score ≤ 62.50%	Not good	8	7.69%
25.00% <score ≤ 43.75%%	Very Not Good	-	-

Students' responses to the ecosystem *e-module* can be seen in Table 5. The results of the analysis of student responses in class X IPA 1 34 students, X IPA 2 34 students, and X IPA 3 35 students with a total number of students there were 103 students obtained an average of 99.02 % very good category because the percentage of student responses ≥ 62.50%. The results of student responses indicate that *the e-module* can be used as effective teaching material. Some students gave their opinion through a response

questionnaire.

The *e-module* contains videos that are in English and can be translated, but some students had difficulty activating *subtitles*. In the ecosystem learning process with the *e-module*, students were interested in learning to use *the e-module* because there are various colorful pictures and animated videos in the ecosystem *e-module* that attract students' attention and help students to improve their analytical skills, as well as the material presented in the *e-module. E-module* is not too dense like the one in the printed book. Klement *et al* (2014) stated that learning using electronics can attract students' attention which can be widely used as a distance learning resource. So *the e-module* ecosystem based on *inquiry learning* is suitable for use in learning.

The response *to the e-module* ecosystem based on *inquiry learning* was carried out by a teacher who taught class X SMA Negeri 1 Bandar and used it as a reference for improving the *e-module*. The results of the assessment are based on aspects of (1) content feasibility, (2) language, and (3) usefulness. The results of the assessment are presented in Table 6.

Table 6. The results of the teacher's response are E-module on a large scale

No	Assessment Aspects	Percentage	Criteria
1.	Content Eligibility	100%	Very workable
2.	language	100%	Very workable
3.	Benefits	100%	Very workable
Score obtained			**80**
Total score			**80**
Percentage			**100%**
Criteria			**Very workable**

At the end of the large-scale trial, an evaluation of the *e-module* ecosystem product based on inquiry learning was carried out by the teacher and students using a questionnaire instrument. Based on the results of the teacher's responses to the *e-module* in Table 6, the teacher's responses indicate that *the e-module* is very applicable in learning with a percentage score of 100% because the percentage obtained from the teacher's responses is ≥62.50%. It is concluded that *the e-module* is an ecosystem-based *Inquiry learning* is appropriate for biology learning, especially ecosystem material. Responses from the biology teacher indicated that *the e-module* made students happy in learning because it was practical and concise, and the material presented using audio-visual in the form of photos and videos helped students in learning ecosystems. The ecosystem *e-module* is a teaching material that has a new appearance and features at SMA Negeri 1 Bandar. Based on the results of the teacher's responses, shows that *the e-module* ecosystem based on *inquiry learning* can be used as an effective learning resource for students after carrying out large-scale trials.

CONCLUSION

Based on the results of the development of inquiry learning-based ecosystem *e -module*, it can be concluded that the *inquiry learning*-based ecosystem *e-module teaching materials* developed are feasible to be applied in learning for high school students in class X IPA where from the results of responses and student responses get percentages ≥ 62.50 %. The learning outcomes of class X science students in the study met the classical completeness criteria with a percentage of ≥ 85%.

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