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Integrated Science Education Mobile Application: Edukit for 21st Century Students

Aplikasi Ilmu Pengetahuan Alam Terpadu: Edukit untuk Siswa Abad 21

Erni Yulianti[1], Desta Wahyu Maharani[1], Erti Hamimi[1]*
[1]Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Negeri Malang, Indonesia

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**Correspondence:*
Erni Yulianti
rni.yulianti.fmipa@um.ac.id

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The aim of this study is to develop a valid and practical science learning media that integrated with mobile application (EduKIT). This EduKIT provide activities so students can have experiences to string and think solution about any problems integrated by technology as demanded of Education in 21st century. This research using ADDIE model which is only limited to the development stage. At each stage, an evaluation process is carried out to produce the maximum product. To measure the validity and feasibility of the media, an instrument in the form of a questionnaire was used. Quantitative data is obtained from the score given by the validator against each criterion and indicator on the validation sheet. While the qualitative data is obtained from the advice given by the validator. The result shows that the EduKIT was highly valid to use with the percentage 98% and 99% for validation media and content validity respectively. This assessment was tested on two science education experts. While the result for the readability test by five teachers was 96% and 91% from ten junior students. Those percentage (>90%) show very practical and highly valid to be used. Based on the results of the validation and readibility test, it can be concluded that EduKIT was valid and practical, so it is suitable for students to use as a learning medium to practice problem solving skills in preparing the 21st century generation.

Keywords: Learning Media; Problem Solving Skill; Educational Kit; Mobile Application

INTRODUCTION

The development of science and technology in the 21st century is rapidly increase and competition between individuals is also more intense. The intense competition in the era of globalization has affected all aspects of life including in the field of education, especially Science Education (Antony et al., 2019). Science deals with learning through natural phenomena that can be identified systematically through scientific steps (Yulianti & Zhafirah, 2020). Science learning for Junior High School levels is presented in a complete and non-partial form based on integration according to the 2013 Curriculum guidelines.

Implementation of the 2013 Curriculum requires several pattern improvements in the learning process. The teacher has the task of delivering material by relating it to real situations, so that *students* can apply it in life based on their knowledge (Ismawati, 2017). Judging from several basic competencies, the material covering environmental problems is contextual and involves the ability to analyze to solve solutions (Luthfi et al., 2017).

Science materials or topics, especially environmental pollution and global warming, are applicable and contextual (Murtyningsih, 2014). One of the themes on environmental pollution is that students are expected to be able to provide solutions based on environmental problems (Luthfi et al., 2017). Meanwhile, the theme of global warming is expected that students will be able to understand the process and evaluate the activities that cause global warming (Septaria, 2019). The learning objectives will be achieved if students have the ability and skills.

Problem solving skills are one of the important skills for students to have high knowledge according to the 21st century (Irsal et al., 2017). Problem solving skills are defined as basic skills that need to be developed to solve problems through gathering facts, analyzing information, arranging alternative solutions and selecting the most effective solutions (Dewi et al., 2014). Problem solving skills can support students to make rational and correct decisions (Lestari & Djukri, 2019). However, this is contrary to the facts in the field. It is shown from the results of PISA in 2018 that Indonesia is in the bottom 10 with the science ability category is ranked 71 out of 79 countries participating in PISA. Basically, the assessment conducted by PISA emphasizes student skills as the development needs of 21st century education, but based on PISA's records, 21 countries do not yet have a curriculum that is focused on future planning according to the needs of globalization. This causes the learning process to not optimize students for skilled problem solving. Low problem solving skills are caused by several problems, namely the rare use of interesting and varied learning media so that students tend to memorize concepts compared to applying science concepts (Susanti, 2014), practicuuum is not implemented in the learning process ((Yennita et al., 2013), limited tools and materials (Integrated Instrument Box) and inadequate laboratory space ((Marcella et al., 2018). Based on the facts in the field, students in the implementatidon of the experiment were busy assembling tools according to procedures and data collection without giving them the opportunity to think (Sutarno et al., 2017). One solution to overcome these problems is by training students' problem solving skills. The reason is because higher order thinking skills help students to solve a problem (Rahmawati et al., 2017).

Learning media is one of the right solutions to optimize problem solving skills. Modern learning using technology-based learning media allows students to study anywhere. Through existing media, learning is not teacher-centered, but student-centered (Yetri et al., 2019). Research conducted by (Raja & Nagasubramani, 2018) stated that the use of technology as a medium of learning shows that the delivery of material becomes easier and students become more interactive. The use of media in learning activities including science education KIT (EduKIT), can support the achievement of learning success (Mahnun, 2012).

EduKIT is suitable for solving the above problems. EduKIT is a science laboratory equipment packaged in a modular form of a simple Integrated Instrument Box (Edukit) which is versatile and easy to use anytime and anywhere (Sasmita, 2017). EduKIT has been developed quite a lot, for example Edukit on optical instrument material. The education developed was only limited to the experimental tool set and student worksheets (Cords et al., 2012). The deficiency of this education does not lead students to solve problems independently. This is because students are more preoccupied with assembling experimental tools rather than discovering concepts.

The solution to the problems will be more complete if Edukit is equipped with a user guide and mobile application. The content in the Mobile application needs to be developed because currently almost all students are technology literate, especially smartphones. The use of mobile can make students understand easier and save time. Learning using mobile applications from 38 students obtained significant results which were marked by an increase in students' speaking and thinking skills. However, EduKIT that integrated with mobile application never been developed by previous researchers. So, the purpose of this research is to produce EduKIT integrated mobile application which valid and practical to train problem solving skills on the theme of environmental pollution and global warming.

METHODS

This research using R&D (Research and Development) method that adapted ADDIE model. The ADDIE model can be seen in Figure 1. This development research is limited to four stages, namely (1) analysis, (2) design, (3) development, and (4) evaluation. At the analysis stage (1), needs analysis and analysis of the learning process are carried out to determine the gap between real conditions and desired conditions. Learning process analysis is used to determine the extent of availability facilities and infrastructure for the learning process. At the design stage (2), the components and content of the application are designed. The development stage (3) is the process of

realizing the product design into a tangible form in the form of science EduKIT. At each stage an evaluation (4) is carried out as material for product revision.

The subjects of this development validation were two science lecturers as an expert validator, five science teachers, and ten students of SMPN 1 Campurdarat Tulungagung with a product trial design using a closing assessment questionnaire. The instrument used in the development of this integrated science mobile application is a questionnaire validated by experts with a score of 98% in the valid category. In addition to media and material validation, a readability test was also conducted on teachers and students. A questionnaire was made to determine the level of feasibility of the product developed by obtaining qualitative and quantitative data. The scale used in this study used a Likert scale and Guttman scale. Likert scale questionnaire in the form of a rating scale with 4 answer choices.

[Figure 1 about here.]

The use of the Guttman scale in the questionnaire is used to assess the correctness of the concepts in the resulting learning media. The questionnaire with the Guttmann scale consists of answer options "Yes" if the concept is correct and "No" if the concept is wrong. The data analysis technique was used to process the validation result data by calculating the average answer score for each subab.

The percentage value that has been obtained is converted into qualitative data based on the level of validation achievement criteria. The criteria for achieving the validation level are shown in Table 1. The learning media for science integrated mobile application can be said to be valid if it obtains a validity percentage of at least 61%. If the percentage of the product gets a value below 61%, it can be said that the media being developed needs to be revised again so that it becomes a better product and is suitable for widespread use by users.

The EduKIT product is integrated with a mobile application which has been validated by two experts, five teachers as education practitioner, and ten students as product user. There are 2 types of data from the validation test, namely quantitative data using the calculation of the average score and qualitative data obtained through comments and suggestions from the validators. The quantitative data were analyzed by calculating the average score, while the qualitative data were analyzed and revised according to the suggestions given by the validators for product improvement.

RESULTS AND DISCUSSION

The previous study, science EduKIT was developed in optical instrument learning in the form of experimental set of tools and student worksheets (Cords et al., 2012). However, it has not directed students to solve problems independently. This is because students are busy in assembling experimental tools than finding concepts. The science material kit was developed in the form of an experimental tool by emphasizing experimental results rather than the student learning process (Jones et al., 2012). This development research resulted in an experimental tool in the form of an integrated science education to train students' problem-solving skills on the theme of environmental pollution and global warming.

There are four science education products that are developed according to the Basic Competency (KD) in the 2013 Curriculum. The first EduKIT Water Filtration experimental product as a problem-solving water pollution solution. Second, Biofilter experiment that produce to gain students' problem solving in air pollution problems. Third, Pyrolysis of Plastic Waste experiment to deal with soil pollution. The last Green House Effect experiments to determine the process of the greenhouse effect. The four science EduKIT products contain experimental tool partitions, in-app content, and user manuals. The tools and materials for the EduKIT experiment were packaged in a box made from "Number. 30" boots coated with an "eva" type sponge as a barrier between the tools and materials. EduKIT box and each experimental tools can be seen in Figure 2.

The science EduKIT manual book was printed using A5 size art paper (14.8 cm x 21.0 cm). The front and back covers use "AP paper" with a weight of 260 gram and the contents of the book use "HVS BB laser paper" which has a thickness of 80 grams. The components of the manual book consist of work safety, experiment objectives, let's formulate, think, what we need to prepare, experimental steps, experimental data, let's discuss, info boxes, application instructions and barcodes. All those components related with problem solving activities.

The Guidebook (manual book) was made as a reference for students in conducting experiments on environmental pollution and global warming, so that the implementation was directed in accordance with the expected goals. This book contains various kinds of information and activities related to science education with adjusted indicators of problem-solving skills. The cover provides information to the reader regarding the identity of the book that has been written. The cover of the educational manual can be seen in Figure 3(a) for Biofilter Experiment, Figure 3(b) Water Purification Experiment, Figure 3(c) Plastic Waste Pyrolysis, and Figure 3(d) Green House Effect Experiment. The contents contained in the experimental manual are used to train and make it easier for students to do experiments. Before students use EduKIT, it will be available in a work safety information book that needs to be considered to avoid the risk of accidents. The work safety sheet can be seen in Figure 4(a).

The objectives section of the experiment is useful for providing information to the reader regarding the goals to be achieved. The objectives of the experiment (Figure 4(b)) are adjusted to the Basic Competencies (KD) of the 2013 Curriculum. The next section contains an activity sheet (Figure 4(c)), let's formulate and let's think aimed at limiting and planning solutions to environmental problems. This activity is one proof of the indicator of problem-solving skills, namely

planning for problem solving. This book also contains additional information to elaborate students' knowledge of the topic. It can be seen in Figure 4(d) entitled “Did you know?”. Did you know page aims so that students can identify problems of environmental pollution and global warming based on the information that has been presented.

In the manual book there are experimental steps to give instructions for students when conducting experiments to achieve the expected goals. Experiment procedure can be seen in Figure 5(a). The results of the experiments that have been carried out can be written on the data collection, see Figure 5(b). The activities of students in the experimental procedure and data collection based on the experiment are proof to achieve problem-solving skills through indicators of doing problem solving plans.

At this activity using EduKIT, students give opportunity to do discussion with their friends. That activity called “Let’s Discussion” that shown in Figure 5(c). In this activity students hold discussions with groups to answer the questions and review their experiment. Students’ activities on “Let’s Discussion” part are one of evidence to train students’ problem-solving skills through indicators “re-examine”. At the last part of this stage is “Additional Information” in Figure 5(d). This part will help students to achieve complete and integrated information based on the experiment and contextual case.

At the beginning page of manual book, there are some information that guide students to use this integrated EduKIT with mobile application. Applications developed to accommodate this education are called i-STEM. This application can be installed at the smartphone, so students can access it anytime and everywhere. This page contains a video introduction to EduKIT and an experimental video uploaded on YouTube and converted into a QR Code. The display of instructions for using the i-STEM application and introduction to education is shown in Figure 6.

[Figure 2 about here.]

[Figure 3 about here.]

[Figure 4 about here.]

[Figure 5 about here.]

[Figure 6 about here.]

The results of this product development can be used by teachers as an alternative learning media that is effective and efficient. For seventh grade students of SMP/MTs can be used as learning resources and media that are able to practice problem solving skills in learning activities, especially experiments on environmental pollution and global warming.

The assessment aspects of media expert validation include EduKIT media validation, Manual book Validation, and i-STEM application content. The results of media validation are shown in Table 2. Based on Table 2, the eligibility of IPA Education gets a percentage of 99%, while the eligibility of the Manual and Content in the application gets a percentage of 99% and 98%, respectively. The average percentage of these three aspects is 98% with the valid category.

Products that have been developed, in addition to media feasibility testing, material feasibility tests are also carried out. There are 3 aspects that are assessed, including the feasibility of attributes, the suitability of the manual with problem solving skills, and the correctness of the concept. The results of material validation for these three aspects can be seen in Table 3. Based on the data in Table 3, the feasibility of IPA Edukit is in the highly valid category with an average percentage of 99%. There are 3 aspects of the evaluation of the material validation test, namely the feasibility of the attribute 99%, the suitability of the manual with problem solving skills 100%, and the correctness of the concept 100%.

The development of the IPA Edukit integrated mobile application after being validated by an expert then carried out by a legibility test. The readability test was conducted by 5 science teachers and a small group of 10 students. The EduKIT readability test by the science teachers consist of 4 criteria, includes the EduKIT assessment, Manual book, and Content in the Application.

[Table 1 about here.]

[Table 2 about here.]

[Table 3 about here.]

[Table 4 about here.]

Table 4 shows the readability from the students as product user. There are three aspect that collect from this stage. The first aspect is readability of EduKIT product and reach 99% that means EduKIT product very practice to use. The second aspect is Manual book readability, student feel this manual book very practice that shown in the percentage reach 99% for this aspect. The last related with content in i-STEM application. That aspect reaches percentage less than two aspect before, only 98%. The average for students’ readability is 98% that’s mean EduKIT product, manual book, i-STEM content very practice to use in the science learning.

Media in the form of integrated science education, mobile application, is more practical and complete to use during the experiment. By doing experiment students will feel easier to construct understanding, gain their problem-solving skills, also trigger students’ experimental skills. The specification of this goal is to develop learning media that is not only interesting but also trains students to be skilled in solving problems through the experiment. The results of validation by expert lecturers and teachers readability tests show that science education products integrated with mobile applications are of highly valid. This means that the science education media is an effective and easy

to use media. This is in line with Pramudya, et al. (2016) research that shows that the use of science education can improve skills and students' curiosity in the learning process. The weakness of this research is in the i-STEAM mobile application, it can only be used online. The science education content in the i-STEAM application requires a fairly large internet quota.

Learning process when using EduKIT has a positive impact on teachers and students (Young & Lee, 2005). EduKIT has the advantage that it can be used by students both independently and with guidance from the teacher, the product can be used to train students' skills in solving problems. Every activity listed in the manual books it is adjusted to indicators of problem-solving skills so that the EduKIT is integrated with mobile application as an alternative to overcome students' problem-solving skills.

Global warming and environmental pollution are real materials in everyday life. Many environmental problems are related to the topic such as air pollution, plastic pollution, and so on. There is a need for media that trains students to be able to solve environmental problems wisely (Yulianti et al., 2021). One of them is by practicing experimenting using EduKIT. EduKIT can train students to solve real live problem using miniatures or props that represent real problems in daily life. In addition, the integration of technology in the learning media is able to foster students' motivation and in accordance with the development of the current digital era (Hidayat et al., 2021). By using this EduKIT students will be more motivated to learn science, be able to gain problem solving skills and solve simple problems related to environmental pollution and global warming.

CONCLUSION

The development of the EduKIT integrated mobile application has been adjusted to the indicator of problem solving skills to foster students' problem solving skills in preparing the 21st century generation. The science education developed is a practical and valid, so that can be complete learning medium that makes it easier for students to do experiments. Suggestions for the use of EduKIT, before conducting an experiment it is necessary to understand the experimental manual and the EduKIT needs to be tested for its effectiveness before it is used by the wider community.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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TABLE 1 / Validity Levels

No.	Percentage (%)	Validity of Criteria
1.	$x < 20$	Invalid
2.	$20 < x \leq 40$	Less
3.	$40 < x \leq 60$	Enough
4.	$60 < x \leq 80$	Valid
5.	$80 < x \leq 100$	Highly Valid

TABLE 2 / Quantitative Data for the Media Validation

No.	Aspect	Percentage (%)	Category
1	EduKIT Product	99	Highly Valid
2	Experiment Manual Book	99	Highly Valid
3	App Content	98	Highly Valid
Average		98	Highly Valid

TABLE 3 / Quantitative Data for the Content Validation

No	Aspect	Percentage (%)	Category
1	Attribute	98	Highly Valid
2	Manual Book	100	Highly Valid
3	Conceptual Correctness	100	Highly Valid
	Average	**99**	**Highly Valid**

TABLE 4 / Readability Data from Students

No.	Aspect	Percentage (%)	Category
1	EduKIT	99	Highly Practise
2	Experiment Manual Book	99	Highly Practise
3	App Content	98	Highly Practise
	Average	**98**	**Highly Practise**

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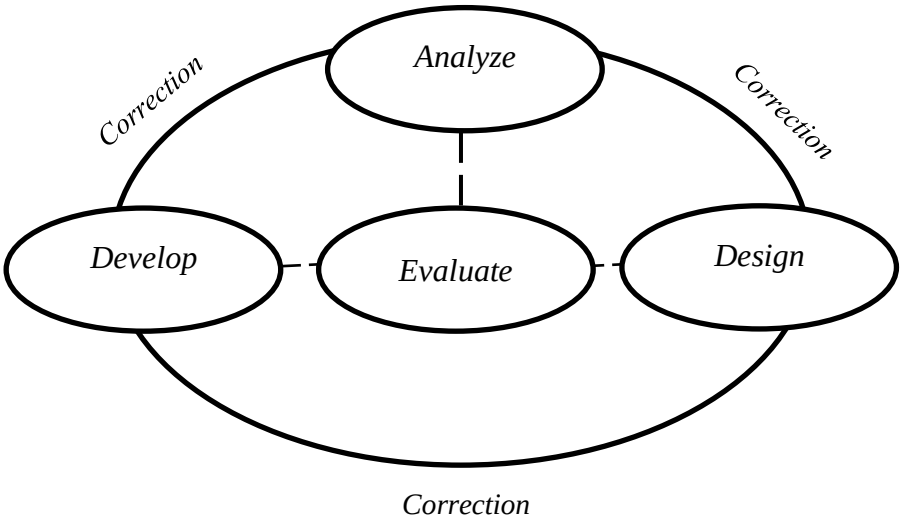


Figure 1. ADDIE Approach for the Research and Development Addapted from Branch (2015).

(a) **(b)** **(c)** **(d)**

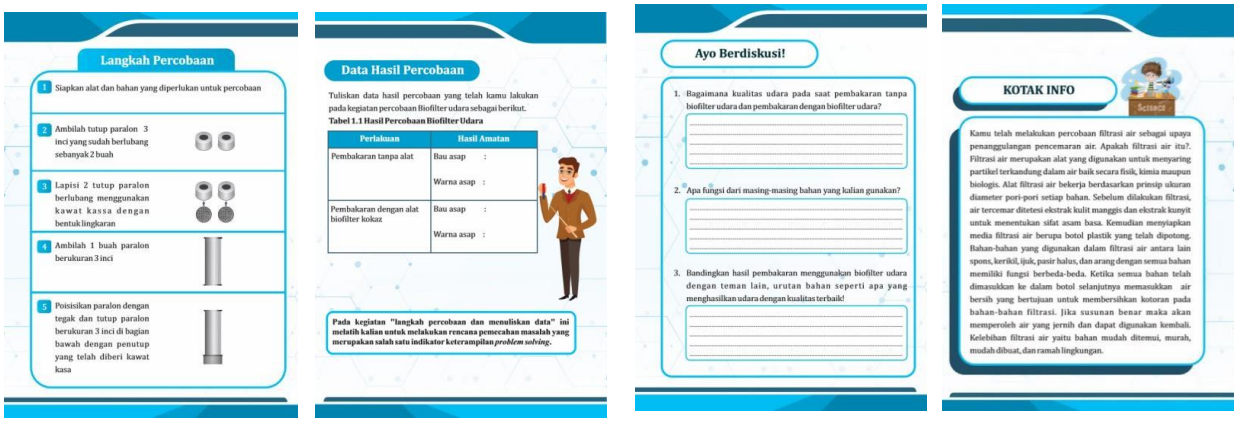
Figure 2. (a) Science EduKIT Box, (b) Biofilter Experiment, (c) Water Filtration Experiment, and (d) Green House Effect Experiment.

(a) **(b)** **(c)** **(d)**

Figure 3. Cover of Manual books of (a) Biofilter, (b) Water Purification, (c) Plastic Waste Pyrolysis, and (d) Green House Effect.

(a) **(b)** **(c)** **(d)**

Figure 4. Pages for (a) Safety Work, (b) Experimental Objectives, (c) Activity Guidelines, and (d) "Did You Know?"



(a) **(b)** **(c)** **(d)**

Figure 5. Displays of (a) Procedure, (b) Data Collection, (c) "Let's Discussion", and (d) Additional Information.

(a) **(b)** **(c)** **(d)**

Figure 6. Displays of (a) i-STEM App Usage Instruction, (b) Experimental Video Barcode, (c) "We Need to Know" Page, and (d) YouTube Video Screenshot.