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EFFICIENCY OF CREATIVE THINKING ABILITY IN AUGMENTED REALITY-BASED LEARNING MEDIA THE ACID RAIN THEME

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ABSTRACT

This research was conducted due to the lack of student's awareness of the phenomenon of acid rain. The phenomenon of acid rain can be harmful to health and ecosystems. Whereas acid rain can be prevented by increasing the awareness of students by improving the quality of education, especially the ability to think creatively, which is expected to help find solutions to minimize the impact of acid rain. However, students in Indonesia have a low quality of education which causes students' creative thinking skills to be below. This study aims to determine the efficiency of Augmented Reality-based learning media in the development of creative thinking skills of seventh-grade students on the theme of Acid Rain. Augmented Reality-based learning media is a technology that combines 2D and 3D virtual objects from interactive applications, thus helping in growing students' creative thinking skills. The research method used is Research and Development (R&D), according to Thiagarajan (1974), which was adapted based on the 4-D model. This model consists of 4 stages of development, namely define, design, develop, and disseminate. But the research is limited to the development stage because this research only focuses on the efficiency level of the Augmented Reality-based learning media developed. The results of the study based on the efficiency test of learning media based on Augmented Reality with the theme of acid rain for class VII SMP obtained an average value of 88.5% in the very efficient category.

Keywords: Learning Media Based on Augmented Reality, Acid Rain, Creative Thinking Ability.

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Introduction

Indonesia is one of the developing countries that have waste disposal problems from human activities (Bakar & Ilkan, 2016). The increase in human activities is directly proportional to the increase in technology which results in the proliferation of vehicles, industrial factories, and power plants that spread pollutants every day and cause air pollution (Abidin et al., 2019). One of the impacts of air pollution is acid rain (Satriawan, 2018). The hazardous compounds that participate when it rains, such as SOx and NOx so, form sulfuric acid and nitric acid are called acid rain (Sudalma & Purwanto, 2012). Environmental pollution that causes acid rain can be prevented and reduced by increasing public awareness, especially among the young generation, through improving education quality.

In this century, education is the easiest way to spread knowledge (Asshiddiqi et al., 2021). However, Indonesia still has yet to get the development of education quality, for example, science (Dewi et al., 2021). This is evidenced in the research of Yuniarti (2015), through *Trends in International Mathematics and Science Study* (*TIMSS*) obtained in 2011 Indonesia's science achievement score of 406. The score is based on an average TIMSS score of 500 points calculated from higher-order thinking skills. Learners. These points place Indonesia in the *Low International Benchmark* category and make Indonesia rank 40th out of 45 countries. The low score of student achievement indicates the low quality of education in Indonesia. People who have low-quality education create a lack of awareness and innovation in preventing and overcoming air pollution that causes acid rain. Based on the statement of Cahyanita & Sugiarti (2018), through TIMSS it can be seen that high-level thinking skills, especially the creative thinking abilities of students in Indonesia, are included in the low category. Therefore, Indonesian students need further development of creative thinking skills (Aripin & Purwasih, 2017; Havita et al., 2021).

Based on the results of interviews with _IPA teachers_ at MTsN 2 Cilegon, SMPN 3 Cilegon, and SMP Mutiara Bunda Cilegon stated that these schools have used integrated learning, but in reality, the science learning process shows that teachers are not too familiar with the integrated learning model because of the teacher's ignorance when asked questions about the model. The cohesiveness *is integrated, shared, webbed, connected*, etc. The same condition was reported by (Febriyanti et al., 2022). In the SMPN 3 Cilegon and MTsN 2 Cilegon, they have not provided an assessment of the teacher's creative thinking skills specifically, such as the HOTS questions. As for those who received the HOTS questions, the student's creative thinking skills according to the teacher were still not good (Utami et al., 2022). In the SMP Mutiara Bunda Cilegon, teaching and learning activities have not used interactive multimedia learning media. Therefore, it can be seen that the activities of students in teaching and learning activities in terms of creative thinking skills have not run optimally at MTsN 2 Cilegon, SMPN 3 Cilegon, and Mutiara Bunda SMP Cilegon.

Higher-order thinking skills are obtained from teaching and learning activities directed by the teacher in order to motivate, and during this period, the teacher provides full support for students' creativity which is also called creative thinking (Faturohman et al., 2020). According to Mustaqim (2017), to grow creative thinking skills, it is necessary to develop integrated science learning media whose efficiency of use refers to creative thinking indicators. Based on the statements of Anggraini (2021), learning media is one of the things that teachers really need in teaching and learning activities. Sourced from the narratives of several students, the interactive learning media used is very interesting and efficient because the content is in accordance with the material, equipped with pictures of other activities, and eliminates boring situations (Fitria, 2014). Examples of developing new interactive learning media include using *Augmented Reality* learning media (Saurina, 2016). *Augmented reality* has the meaning of a technology that integrates 2D and 3D virtual objects from applications interactively; virtual objects will be projected in real-time (Pramono, 2013). *Augmented reality* that is used for learning media can also foster student interest in the learning process because *Augmented Reality* has the nature of combining with the virtual environment and can directly increase students' imagination of the real environment (Hamdani & Sumbawati, 2020).

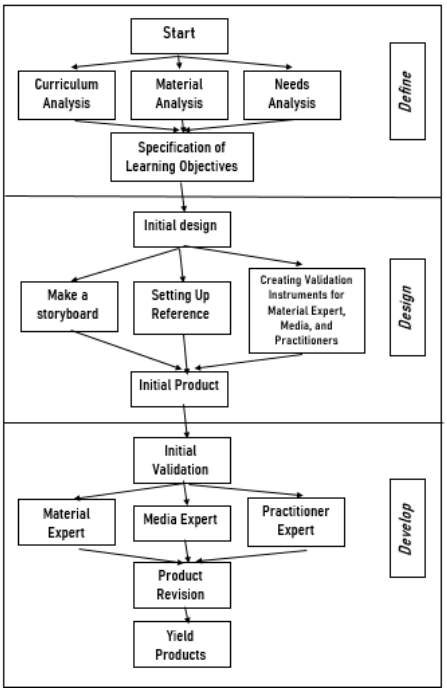
On this occasion, the product that will be produced is *Augmented Reality*-based learning media. The application used is an assembler. The new assembler application was inaugurated in 2020. Based on an interview with a Semarang State University Lecturer, Dr. *Setya Chendra Wibawa*, S.Pd., M.T, said that by using the *Assembler Edu* application, teachers could more easily create technology-based learning media. The easier it is to make media, the teacher will not be burdened and make the material given to students more efficient. The manufacturing process is difficult and requires special skills in making *Augmented Reality*-based

learning media are rarely used by teachers. So, the researchers are interested in using the application so that students and teachers are accustomed to using AR technology that focuses on user convenience in its use.

Augmented Reality-based learning media contains materials that are integrated using the integrated model. The acid rain theme will be used because Banten, especially Cilegon City, is a province in Indonesia that has a high level of air pollution (Aziz & Huda, 2020). In this study, researchers want to cultivate creative thinking skills through interactive media that can make teaching and learning activities very interesting. This study, it can increase the love for the environment of students so that students can reduce environmental pollution and protect the environment (Sjaifuddin et al., 2019). Therefore, the researcher decided to carry out research entitled "Development of *Augmented Reality*-Based Learning Media with Acid Rain Theme in Developing Creative Thinking Skills for Junior High School Students" whose efficiency level can be known from the validity of the product..

Research Methods

In this study, a 4-D development model was applied. The types of research used are categorized as research and development, which are obtained from the 4-D model. There are four steps in the *Research and Development* research model, including *defining, designing, developing,* and *disseminat*ing (Thiagarajan et al., 1974). This research only focuses on the level of efficiency of Au*gmented Reality*-based learning media; because of that, researchers limit it to the *develop*ment stage only so that the flow of *Augmented Reality*-based learning media research can be seen in Figure 1 below.



Gambar 1. Alur Penelitian R&D

Source: (Restricted from Thiagarajan et al., 1974)

The criteria selected for these expert trial subjects were selected academically. Material experts are lecturers of subjects related to related subjects, media experts are lecturers who are experts in making learning media, and expert educators are teachers who teach science in junior high schools. Validation of research products carried out by Lecturers at the University of Sultan Ageng Tirtayasa and teachers of junior high school science subjects by filling out expert validation assessment instruments regarding statements of the components of learning media based on *Augmented Reality* with the theme of acid rain. The teachers selected to fill out the research instrument included SMP Mutiara Bunda Cilegon, SMPN 3 Cilegon, and MTsN 2 Cilegon. The time of research will be carried out in February 2022. To develop *Augmented Reality*-based learning media, researchers use a questionnaire sheet to find out the efficiency of the product being developed. This study uses a validation questionnaire sheet. To get an efficiency assessment regarding the product holds being produced, a validation questionnaire is used to assess the product. For the purpose of the product validation questionnaire, it is shown to material experts, media experts, and expert practitioners. The selection of the type of data in the form of a questionnaire was adjusted to the research design, namely experimental design with individual trials.

The research data was obtained from the trial process, which was divided into two parts. The data

taken are quantitative data and qualitative data. The process of analyzing the data uses ordinary calculations. In this trial activity, qualitative data was taken in the form of criticism and suggestions obtained from material experts, media experts, and expert practitioners, which were then collected to improve *Augmented Reality*-based learning media products. The quantitative data generated from the results of the validation instrument sheet will then be converted into qualitative data using a Likert scale to understand the quality of learning media with the explanation below:

Tabel 1. Scoring Criteria

Nilai	Kriteria
4	Sangat Baik
3	Baik
2	Kurang Baik
1	Sangat Kurang Baik

(Modified from Sudijono, 2012).

The questionnaire data that has been given after that is calculated by the following formula:

$$NP = \frac{R}{SM}\ x\ 100\ \%$$

Description:
NP = percentage value obtained
R = the score obtained
SM = highest score
100% = fixed number (Purwanto, 2013)

Then converted, the scores that have been obtained in line with the categories in table 2 below:

Table 2. Category of *Augmented Reality*-Based Learning Media Efficiency

Skor (%)	Kategori Efisiensi
81,25 < x ≤ 100	Sangat Efisien
62,50 < x ≤ 81,25	Efisien
43,75 < x ≤ 62,50	Cukup Efisien
25 < x ≤ 43,75	Tidak Efisien

(Modified from Sudijono, 2012).

Result and Discussion

The purpose of the scores that have been obtained in this study is to create and measure the efficiency of *Augmented Reality*-based learning media on acid rain science subjects to foster creative thinking skills at the junior high school level. The product development process applies the *Research and Development* (R&D) method and the limited 4-D development model. The efficiency level of *Augmented Reality*-based learning media is calculated using a validation questionnaire sheet which is then validated by material experts, media experts, and practitioners.

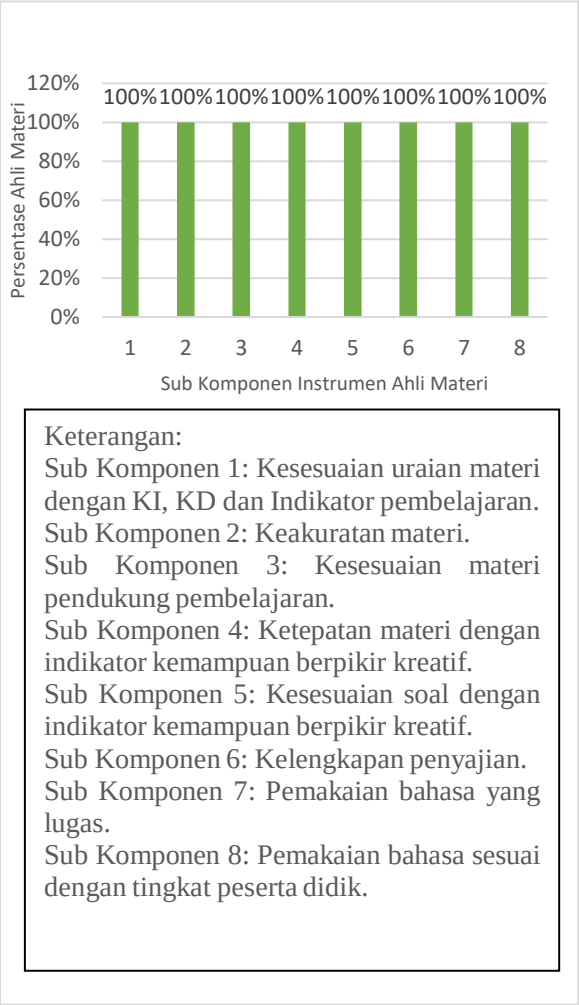
The Thiagarajan model used is summarized in three stages, namely *define, design*, and *develop.* In the *define*d procedure, a very important initial step is carried out in constructing the product, which is divided into four parts, namely curriculum analysis, material analysis, needs analysis, and specification of learning objectives. Furthermore, in the (*design)* there are several stages. The first stage is making a *storyboard*, which is an outline design of the contents of the learning media that will be developed. The second stage is to prepare references in the form of images, *icons*, videos, and illustrations of acid rain which are in line with the sub-materials in the learning media. The third stage is to create an instrument that is used to validate the learning media created by the researcher. The validation instrument developed is aimed at the validation of media experts, material experts, and expert practitioners. And the last stage is to design the initial product of learning media based on *Augmented Reality*.

The development consists of two steps. The first is expert validation which is carried out to determine the level of efficiency of the media that has been made. In the next stage, the product content will be assessed by material experts, media experts, and expert practitioners. The second is the product revision procedure. The validation obtained from the expert team will be used to revise the product so that the *Augmented Reality*-based learning media developed can be perfect. In this study, learning media can be declared efficient if the product obtained is in line with the criteria" (Arikunto, 2016).

The results of material expert validation can be stated that achieving a percentage score of 100% is in the very efficient category. While the percentage score obtained from the validation of media experts is 78.3% in the efficient category. Next, the percentage score obtained from the validation of expert practitioners is 87.3%, with the very efficient category.

Material Expert Validation

Material validation plays a role in providing an assessment of the acid rain material contained in *Augmented Reality*-based learning media made by researchers based on aspects of the material expert questionnaire sheet. The validator in this research is a lecturer at Sultan Ageng Tirtayasa University who is a lecturer in subjects related to related subjects. The following are the results obtained from the calculation of the percentage of material experts.



Gambar 2. Material Expert Validation Result

Regarding the results of the efficiency level score given by material experts on *Augmented Reality*-based learning media, it can be seen in Figure 3 that there are aspects that are divided back into various sub-components. In the aspect of feasibility, the content is divided into five components, namely the accuracy of the material with KI, KD, and learning indicators, material accuracy, material accuracy with learning support, material accuracy with creative thinking ability indicators, and suitability of questions with creative thinking ability indicators. Furthermore, the presentation aspect is divided into presentation completeness. Next, the language aspect is divided into sub-components using straightforward language and language usage according to the level of students. The results of the assessment given by the expert validator are 100% in the very efficient category after conversion.

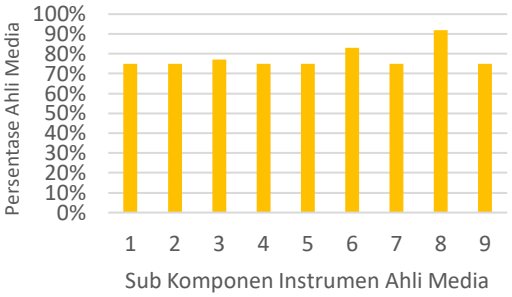
One aspect of the material validation questionnaire instrument is the aspect of feasibility content which achieves a percentage score of 100% in the very efficient category. Based on the opinions of material experts related to KI, KD, and learning indicators, the accuracy and suitability of the material with the level of thinking of students is very appropriate. These results are in accordance with Pakpahan et al. (2022) that the material must be based on achievements with the expected KD because the product is created in order to make students understand the competencies that have been chosen by the teacher.

The presentation aspect achieved a percentage score of 100% in the very efficient category. So it can be stated that *Augmented Reality*-based learning media displays a systematic material structure, and the material is presented in a directed manner and can describe the subject matter of the material well.

The language aspect has two sub-components achieving a percentage score of 100% in the very efficient category. The use of good language and not difficult to understand for students, causes the categories in the language aspect to get a satisfactory assessment from the validator. The following statement is confirmed by Depdiknas (2011), which says that media that uses words that are constructed in a straightforward manner can present a material better.

Media Expert Validation

Media validation is an assessment step carried out by media validators related to products that have been created and sourced from aspects of media expert questionnaires. In this study, the validator is a lecturer at Sultan Ageng Tirtayasa University. He is a lecturer who is an expert in making learning media. The percentage value of media expert validation can be seen in the graph, including:



Keterangan:
Sub Komponen 1: Isi materi
Sub Komponen 2: Soal HOTS
Sub Komponen 3: Desain isi materi
Sub Komponen 4: Desain soal
Sub Komponen 5: Kelugasan bahasa
Sub Komponen 6: Bahasa dialogis dan interaktif.
Sub Komponen 7: Keruntutan keterpaduan.
Sub Komponen 8: Efisiensi media berdasarkan indikator kemampuan berpikir kreatif
Sub Komponen 9: Fleksibilitas media.

Gambar 3. Media Expert Validation Results

The assessment obtained from media experts regarding the level of efficiency of *Augmented Reality*-based learning media can be seen in Figure 4 based on aspects that are divided into various sub-components. In the aspect of the presentation, the researcher divides it into two sub-components, namely, the content of the material and the HOTS questions. Furthermore, the graphic aspect is also divided into two sub-components, namely, the design of the material content and the design of the questions. The language aspect consists of straightforwardness of language, dialogical and interactive language, and coherence of sentence coherence. The learning aspect is divided into two sub-components, namely, media efficiency based on indicators of creative thinking ability and media flexibility. The general percentage score obtained from media experts is 78,3% in the efficient category.

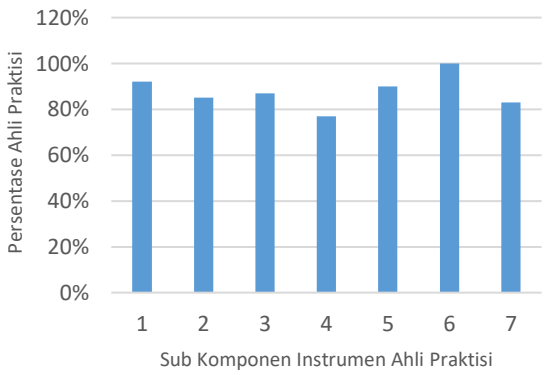
First, the presentation aspect is divided into two sub-components; a percentage score of 75% is obtained in the efficient category. The results given by the validator show that the relationship between the presentation of *Augmented Reality*-based learning media has been made properly and helps the teacher in presenting learning materials.

In the graphic aspect, the researcher divides it into two sub-components to get a percentage score of 75,8% in the efficient category. The assessment of the score was caused by media experts, the visual presentation of this product was quite attractive, the characteristics and font size used were quite appropriate so that it did not make it difficult for students to understand the sentences displayed, as well as the suitability and alignment of color determination on all product components such as images, sentences, or a background that makes the product more aesthetic. This is in accordance with Putri et al. (2022) that the use of various *font*s and the appropriate size of the *font* can be more easily understood on the product and the suitability of determining the pattern on the product, the suitability of colors in the display of words, images, and backgrounds can make the product more attractive.

In the aspect of language, the researcher divides it into three sub-components, achieving a percentage score of 77,7% in the efficient category. The assessment of the score is due to the decomposition of words and language using correct spelling and standard words. Furthermore, the learning aspect gets a value of 83,3% with a very efficient category. According to media experts, it can be concluded that the use of learning media has followed the reference indicators of creative thinking skills and can be used in the learning process. This is also in line with Triyani et al. (2022) that the multimedia structure is very important to be formed systematically and concisely so as not to make it difficult for students to use it.

Expert Practitioner Validation

Practitioner validation is a step to gain value related to *Augmented Reality*-based learning materials and media. In this research, the validator is a science subject teacher who is in schools around Cilegon City. Researchers selected three expert practitioners. The value of the percentage of expert practitioner validation can be seen on the graph, including:



Keterangan:
Sub Komponen 1: Materi yang ditampilkan sejalan dengan KI, KD dan Indikator Pembelajaran
Sub Komponen 2: Struktur materi.
Sub Komponen 3: Pemakaian bahasa pada media pembelajaran berbasis *Augmented Reality*.
Sub Komponen 4: Tata letak gambar sesuai dengan materi
Sub Komponen 5: Ilustrasi sampul dan isi sesuai dengan materi.
Sub Komponen 6: Efisiensi pemakaian media pembelajaran berbasis *Augmented Reality*.
Sub Komponen 7: Fleksibilitas pemakaian media pembelajaran berbasis *Augmented Reality*.

Gambar 4. Expert Practitioner Validation Result

The assessments obtained from expert practitioners 1, 2, and 3 regarding the efficiency level of *Augmented Reality*-based learning media can be seen in Figure 5 based on aspects that are divided into various sub-components. The general score of percentage obtained from practicing experts is 87,3% belonging to the very efficient category.

In the aspect of content/material, which is divided into two sub-components, it achieves a percentage score of 88,5% in the very efficient category. The results given by the validator show that the relationship between the presentation of *Augmented Reality*-based learning media has been made properly and helps the teacher in presenting learning materials. This argument is in line with Ardiansyah & Septian (2019), that in creating content in learning applications it is necessary to match the placement of the display material, practice questions, and learning videos.

In the aspect of language, there is only one sub-component, namely the use of language in the material in *Augmented Reality*-based learning media, achieving a percentage score of 86.6%, having a very efficient category. These results were obtained because the *Augmented Reality*-based learning media that was developed had deciphered words and language with proper spelling and standard words. This is in line with (Irmayta et al., 2017), which state that the question instrument must consider the color of the letters, the size of the *font*, question instructions, image quality, image sharpness, the use of language that is not difficult to understand, and the use of appropriate language in line with the rules of writing.

The display aspect consists of two sub-components getting an average value of 83,3% in the very efficient category. The assessment of the score was caused by expert practitioners, the visual presentation of this product is quite attractive, and the characteristics and font size used are quite appropriate so that it does not make it difficult for students to understand the sentences displayed, as well as the suitability and alignment of color determination on all product components such as images, sentences, or a background that makes the product more aesthetic. This is also in line with Wibawanto, (2017) that for the appropriate treatment of *font* and colors, the same treatment applied to images, animations, sentences, and backgrounds can form a harmonious and artistic result when viewed.

Even though the results of the product assessment have generally been suitable for use, revisions must still be carried out based on suggestions and input from experts. Revisions must continue to be carried out so that the *Augmented Reality*-based learning media that was created can become ideal as a learning media tool to support teaching and learning activities. So, the product can be used comfortably by teachers and junior high school students on acid rain material after being repaired by researchers.

Conclusion

Based on the results of the research, the *Augmented Reality*-based learning media development process has an efficiency level in *Augmented Reality*-based learning media with the theme of acid rain in growing the creative thinking skills of junior high school students found a percentage score of 88,5%, which belongs to the

very efficient category. The results obtained are based on the assessment of the material, media, and practitioner validation questionnaire sheets.

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