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Development of Environmental and Technology Literacy-Oriented Science Comics as a Learning Media on Environmental Pollution

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Abstract: Learning media in schools has provided added value in the teaching and learning process. Science textbooks are not enough to achieve ideal learning. One of them is to use comics which can be said to be a pretty good visual medium. The purpose of this research is to produce an edutainment-based comic learning media that can improve students' environmental literacy and technological literacy. This study uses a research and development model (ADDIE). Researchers used data collection techniques by means of observation, interviews, documentation, questionnaires and tests. The data is processed so that it can improve students' environmental literacy and technological literacy on environmental pollution materials. The subjects in this study were seventh grade students of the Bandung National Junior High School. The instrument used for data collection in this study was a test of environmental literacy and technological literacy. The data analysis technique used mixed type qualitative methods and at the time of product field testing with quantitative methods. In the form of assessments of material experts and media experts, attractiveness questionnaires and class test results.

Keywords: comic media, edutainment science, environmental literacy, technology literacy and environmental pollution.

Abstrak: *Media pembelajaran di sekolah telah memberikan nilai tambah dalam proses belajar mengajar. Buku teks IPA tidak cukup untuk mencapai pembelajaran yang ideal. Salah satunya adalah dengan menggunakan komik yang bisa dikatakan sebagai media visual yang cukup bagus. Tujuan penelitian ini adalah menghasilkan media pembelajaran komik berbasis edutainment yang dapat meningkatkan literasi lingkungan dan literasi teknologi siswa. Penelitian ini menggunakan model penelitian dan pengembangan (ADDIE). Peneliti menggunakan teknik pengumpulan data dengan cara observasi, wawancara, dokumentasi, angket dan tes. Data tersebut diolah sehingga dapat meningkatkan literasi lingkungan dan literasi teknologi siswa pada materi pencemaran lingkungan. Subjek dalam penelitian ini siswa kelas VII SMP Nasional Bandung. Instrumen yang digunakan untuk pengumpulan data dalam penelitian ini adalah tes literasi lingkungan dan literasi teknologi. Teknik analisis data menggunakan metode kualitatif tipe campuran dan pada saat uji lapangan produk dengan metode kuantitatif. Berupa penilaian ahli materi dan ahli media, angket daya tarik dan hasil tes kelas.*

Kata kunci: *sains edutainment, literasi lingkungan, literasi teknologi, pencemaran lingkungan.*

▪ INTRODUCTION

The behavior of students by often littering, shows our concern for a clean environment in the future. This is caused because students have not been invited to solve problems that occur in the environment (Capati 2020; Pratama, Marpaung, and Yolida 2020). The caring attitude of students must be instilled from now on, one of which is through learning media that contains interesting material and visualizations for students. Learning media in schools has provided added value in the teaching and learning process. However, the media and teaching materials circulating in the field

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have not met the government's expectations (Ulfa et al., 2017; Erdoğan et al., 2009). One of the most widely used learning media is visual-based learning media. Visual media can also be interpreted as media that feels human vision or eyes. The function of the media in learning objectives, namely the information obtained in the media must involve students both mentally and in the form of real activities so that learning can occur (Fuadi et al. 2020).

The situation that occurs among students today is different from the past, where nowadays technology has begun to advance and even students can access about environmental pollution problems very quickly. Technology shapes the environment in which humans live and becomes an inseparable part of human life. Technological literacy includes an understanding of technology, how technology is developed, how technology works, how technology affects schools, students and society and how society determines the direction of technological development (Pandian and Balraj 2010; Hayati et al., 2020). The information obtained regarding technological literacy related to the subject matter, namely environmental pollution, is still very less compared to the amount of information about literacy in other fields.

Science learning that is fun and creates an interactive atmosphere is manifested in science edutainment. Science edutainment is defined as an entertaining or fun science learning process (Jyoti 2018; Indriati 2012). The application of edutainment science in science learning is expected to be able to improve environmental literacy and technological literacy through the activities carried out (Arizaldy & Sjaeful Anwar, 2020) The comic media that the researchers will make is based on the Google Play Store because it is different from comic book media, comic media using the Google Play Store is more efficient and saves time and students learn about technology not because of games or things that can make students wrong in using technology (Meisandy, Hayati, and Widiyanto 2020). However, there are many benefits from technology as a learning medium and a means of student learning (Miapyen & Bozkurt, 2020; Watrianthos, 2019).

Based on this background, the researcher developed a comic learning media with the concept of science edutainment with the aim of increasing environmental literacy and technological literacy of junior high school students on the subject of environmental pollution. The material chosen in the development of this learning media is environmental pollution (Sagun and Luyt 2020; Cole and Hamilton 2020). Thus, the aim of this research is to produce a science-based edutainment comic learning media that can improve students' environmental literacy and technological literacy.

▪ METHOD

This study uses the Analysis-Design-Development-Implementation-Evaluation (ADDIE) research and development model. In addition, the ADDIE model is a general learning model and is suitable for development research. The ADDIE research and development model has 5 stages, which include (1) the analysis phase, (2) the design phase, (3) the development phase, (4) the implementation phase, (5) evaluation (Evaluation). At the implementation stage, the learning media was carried out with a quasi-experimental method, which was marked by the presence of a control class with learning media commonly used in schools to be compared with the experimental class using comics learning media, the science concept of edutainment that had been

developed by researchers (Darling-Hammond et al. 2020). The complete stages of the research are shown as follows:

Analysis

The analysis stage here is related to the analysis of needs where in a research conducted, researchers must analyze several elements, especially those that researchers will face related to various kinds of environments, so that it can be found what products need to be developed (Wicaksono, Jumanto, & Irmade 2020). From the results of the needs analysis, we get the results that we have to analyze them, namely teacher analysis, curriculum analysis and student analysis. It is important for researchers to find out how the condition of the teacher when studying, the readiness of the teacher when studying, what kind of learning the teacher provides. Then curriculum analysis helps researchers during the research, what kind of curriculum does the school run or provide. Student analysis must be considered by researchers because the focus of this research relates to students. From the results of the needs analysis, it will be obtained problems or obstacles for teachers and students that arise during the learning process, especially in learning science about environmental pollution. At the time of the needs analysis, the researchers found that teachers did not have interesting sources/teaching materials that could be used for science learning about environmental pollution, students were not given interesting learning, and teachers rarely gave learning about environmental pollution by using interesting learning media. In practice the teacher gives individual environmental pollution lessons to students and this is also not supported by the existence of interesting learning resources in environmental pollution learning. Therefore, it causes students to be less interested and tend to be bored in learning environmental pollution.

Design

According to Robert Maribe Branch (Saputro 2016) said design is an activity to design products according to what is needed. This activity is carried out systematically, namely establishing basic competencies, indicators, objectives, materials, and learning media. From these aspects, it is adjusted to the needs and obstacles in learning that exist at the Bandung National Junior High School, namely, the absence of interesting teaching sources / materials, and the absence of a supportive learning media, then learning is not supported by the facilities and infrastructure that support students in learning. conduct environmental pollution studies. The following are the basic competencies, indicators, objectives, materials and learning media that have been determined.

Next is the design of learning media for comics with the concept of environmental pollution edutainment science. The design of learning media for the science concept of edutainment comics is by determining the format of environmental pollution comics as follows: Comic Media Cover Design, Determination of Comic Media Images, Subject matter that will be displayed in comic media, Storyline in Comic Media, Illustration of Comic Media.

Development

The development stage is carried out to create and test products that have previously been designed at the design stage, Robert Maribe Branch (Saputro 2016).

The development process is carried out to realize the product design in the design stage, from the conceptual framework realized to a product that is ready to be implemented.

If the science edutainment concept comic learning media has been created, the next step is to create a science edutainment science concept comic learning media for environmental pollution using the Google Play Store application or via QR and Barcode Scanner. making comic learning media, the concept of science edutainment refers to the format for making comic learning media, which consists of: 1. Comic Media Cover Design, 2. Determination of Comic Media Images, 3. Lesson Materials to be Shown in Comic Media, 4. Storyline in Comic Media, 5. Illustration of Comic Media. If the development stage has been carried out, the next step is product validation. Validation process by presenting experts such as material experts and learning media experts. Researchers prepare an instrument to measure or assess the material used and the learning media developed. If weaknesses are found in the product, the media must be revised as needed. Material validation and product validation are carried out at a later stage.

Implementation

According to Robert Maribe Branch (Aditama & Lesmana 2020) said implementation is an activity using a product. Learning media that have been developed are implemented in real or actual situations for students. After implementation, an initial evaluation is carried out for benchmarks for the application of learning media that have been practiced for the next stage. The implementation phase will be carried out on class VII students of the Bandung National Junior High School, totaling 15 students. The implementation stage for students is carried out to determine the feasibility of the products that have been made and to knowing the response of teachers and students to the products that have been made, namely the comics learning media of the science concept of edutainment that is applied. The feasibility of the product can be determined by providing a questionnaire on the teacher's response and the student's response to the implementation of comics learning media, the science concept of edutainment, for environmental pollution. The responses of teachers and students can be known after the teacher and students fill out a questionnaire that has been prepared by the researcher.

Evaluation

According to Robert Maribe Branch (Saputro 2016) the evaluation stage is to assess whether each step of the activities and products that have been made are in accordance with the specifications or not. Evaluation is carried out at each stage, namely: Needs analysis, Design analysis, Development analysis, Implementation analysis.

Evaluation is used to see whether the learning system that is being built is successful and in accordance with initial expectations or not. The evaluation stage is based on the learning outcomes by students after implementing the product that has been made by the researcher. Has the program succeeded in increasing the competence of students because of the impact of participation in learning. Then the results of teacher and student responses are used as a guide for researchers to revise better according to needs. Revisions based on the results of these responses were carried out so that the learning media were ready to be applied when learning science on environmental pollution materials.

Data collection tool or research instrument is a tool used to measure natural phenomena and to measure observed social phenomena. The research instruments used in this study are as follows:

Observation made by researchers regarding how the learning process takes place at the Bandung National Junior High School. Researchers did this because in order to get more information about the learning process. In obtaining data from observation, the researcher is the instrument. Researchers saw firsthand how the conditions at the Bandung National Junior High School were, this was used by researchers to weigh what was needed in the learning process. Interview and Documentation, In an effort to obtain more in-depth data or information, the researcher conducted interviews with parties involved in learning at the Bandung National Junior High School, such as the principal and vice principal of the curriculum section, science subject teachers and students. This data is to find out how learning activities take place and how learning is when using media that has been developed by researchers. By using interview guidelines and in disseminating information, documentation can be used as a means of collecting data such as school structure data, names of teachers on duty, syllabus, lesson plans, etc.

Questionnaire or questionnaire is a data collection technique that is done by giving a set of questions or statements in writing to the respondents to be answered. Questionnaires in this study were given to material experts and media experts as well as students who took part in the learning process with this learning media product. The questionnaires used include: a. The material expert questionnaire was used as a research instrument to determine the feasibility of the material presented according to the material expert. This questionnaire aims to evaluate the learning media before being tested. This questionnaire contains aspects to assess whether the environmental pollution learning material using the comic edutainment science concept learning media that was developed is feasible or not. Instruments for material experts are reviewed from the quality of the material and learning. b. Media Expert Validation Questionnaire. For media experts, it is viewed from the appearance and quality of the media. c. Media Attractiveness Questionnaire. This questionnaire is given to students which contains an assessment of the learning media used

Scientific literacy test questions, environmental literacy and technological literacy In conducting the test, it is necessary to have some preparation. The stages of preparation for testing environmental literacy and technological literacy are as follows: a. Determining Material. The material chosen is the science of environmental pollution, this is in accordance with the learning media that has been prepared. The choice of material is seen from the syllabus and its implementation refers to the lesson plan. b. Determining the Type of Question, The questions used are in the form of objective tests, each item is equipped with 4 options. c. Determining Cognitive Level Composition, According to Bloom's taxonomy, abilities can be distinguished into 3 things, namely cognitive, affective and psychomotor. Cognitive abilities are grouped into 6 categories, namely cognitive abilities at the level of knowledge (C1), understanding (C2), application (C3), analysis (C4), synthesis (C5) and evaluation (C6). For affective abilities are grouped into 5 categories, namely recognition (receiving), giving a response (responding), appreciation of values (valuing), organizing (organization) and practice (characterization). And psychomotor abilities are also grouped into 5 categories, namely imitation, manipulation, precision, articulation and naturalization.

Make a Question Grid In making the question grid, it consists of 3 columns,

namely basic competencies, indicators and cognitive aspects. Preparation of Question Items The questions used in the trial consisted of 30 objective items or multiple choice using 4 answer options containing the subject matter of the environmental pollution chapter.

Determine Time Allocation, The time needed to complete the 10-item pretest and posttest test questions is 30 minutes. After the next preparation stage, namely the stage of implementing environmental literacy tests and technological literacy. Where the stages are the instrument about environmental literacy and technological literacy which are tested as many as 30 multiple choice questions with an allocation of 30 minutes to do it for the pretest, as well as the posttest. The total number of questions is 30 questions that have been validated by the science lecturer.

▪ RESULT AND DISSCUSSION

As above, when planning to make comics, we must first design the media, including the initial page or the front page of the comic media as the researcher makes the media with great patience and a combination of informatics media so that children when using the media do not feel bored some of the time. The display will be presented by the researcher in figure 1 as follows:

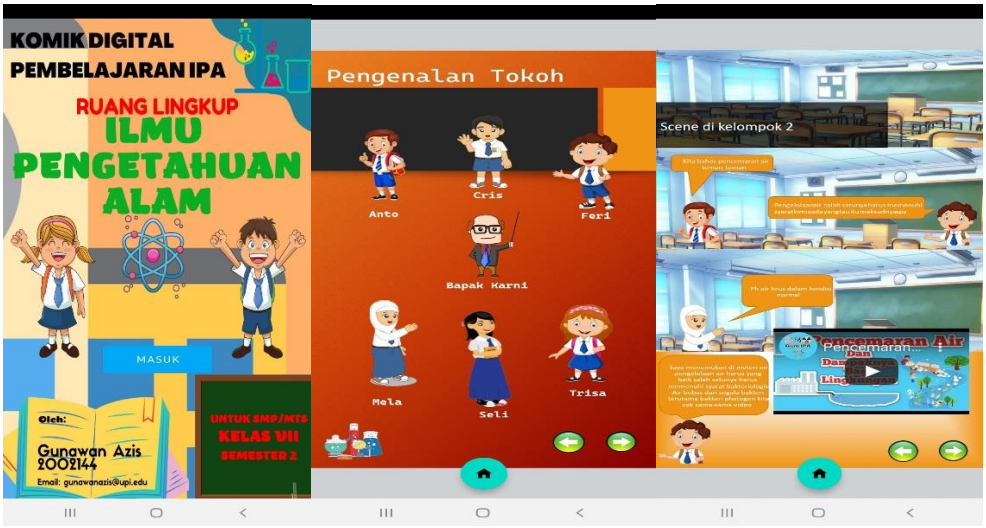

Figure 1. Edutainment science concept comic media

The final result of this edutainment science-based comic media can be used as additional media in learning activities both at school and at home. The results of this media research and development are data about the specific needs needed in developing android-based comic media and media feasibility (Zhong, Chen, and Xuan 2021). The data on the feasibility of android-based comics media was obtained from the calculation of the questionnaire during validation by material experts and media (product) experts as validators and questionnaires to determine student responses (Lo et al., 2022, & Kuttner et al., 2021).

After the product has been successfully developed, the next step is to conduct a media feasibility test by means of media validation. Media design validation is carried out after the initial product creation. There are two kinds of validation, namely material

expert validation and media expert validation. Before validating a design or product, first validate the research instrument by an expert lecturer. Validation sheets were given to 3 material experts and 3 media experts as validators as an attachment to the Material Expert Validation Assessment Results in Figure 2.

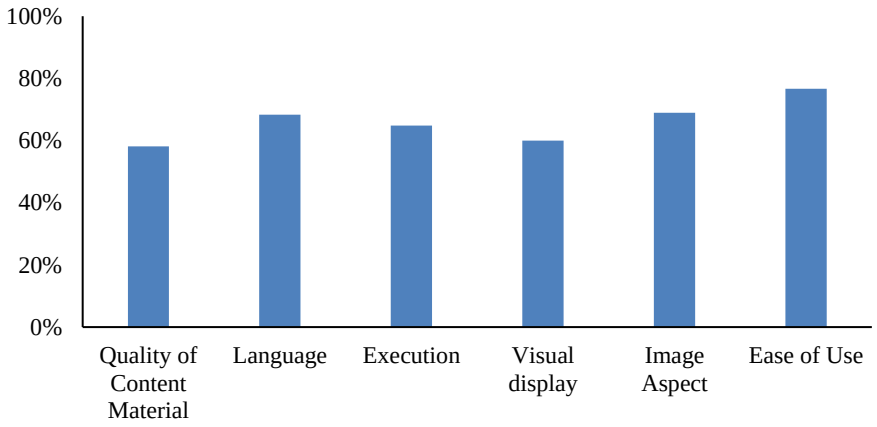

Figure 2. Material expert validation assessment

Based on figure 2, the results of the assessment obtained from the three material experts were then calculated by the researchers calculating the percentage of feasibility scores for each aspect of the learning media in the form of android-based comics using the Likert scale formula. In the aspect of feasibility, the content of the material received a score of 58.1%, for the linguistic aspect 68.3%, for the implementation aspect 64.8%, for the visual display 60.0%, for the image aspect 68.9%, and for the ease of use aspect 76 ,7%. So that the average assessment for all aspects of physics learning media in the form of android-based comics is 66.1%. Validation of media experts is the same as material experts, which is done by filling out an assessment questionnaire consisting of 5 aspects, namely aspects of implementation, language, presentation, comic design and practicality. With a total of 14 statements from all aspects, this assessment was given by 3 media experts, as evidenced by Figure 3.

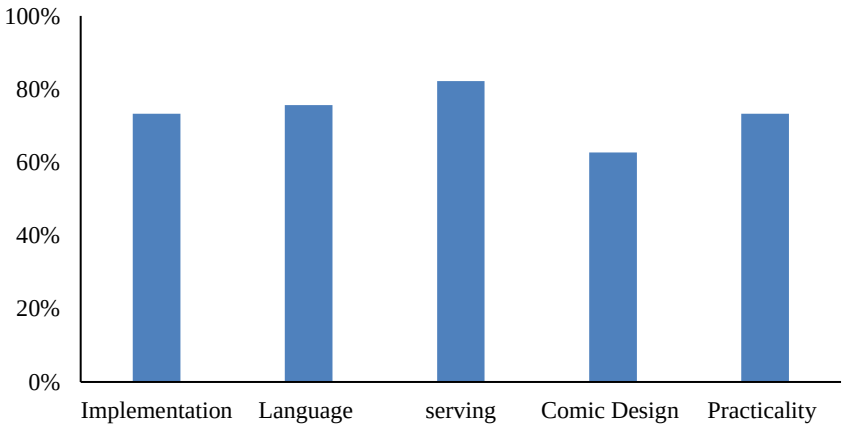

Figure 3. Media expert validation assessment

Based on figure 3 is an assessment of the results of the media expert validation phase I of the three validators. In the aspect of implementation, the percentage obtained is 73.3%, linguistic aspect is 75.6%, presentation aspect is 82.2%, comic design aspect is 62.7% and practicality is 73.3%. So that the average score of these 5 aspects is 74.3%, which means that this learning media is in the proper category. After making revisions to material experts and media experts, then improvements were made so that when tested, students got a good response to the comic media of edutainment science concepts that had been developed. After going through the media testing stage, the final product in the form of comic media for the science concept of edutainment is categorized as feasible and does not require revision so that it can be used in the learning process (Zhong et al. 2021). Excellence Comic-making is an explicit means for me to demonstrate and experience more tacit ways of knowing about complex terms like agency, identity, and meaning-making (Kuttner et al. 2021). Throughout the research process, during children's visits to the library, the children'sinterest in comic books was obvious, and they could often be seen leafing through them, telling stories from the illustrations or asking adults to read the narrative. Children also check out comic books and take them home (Silva 2018).

▪ CONCLUSION

The science edutainment concept comic media that has been developed by researchers is in accordance with the instrument criteria, this edutainment science concept comic media is designed to help students understand the concepts and materials of straight motion that have been taught by science subject teachers in accordance with learning objectives. The media developed by the researcher is very practical because it can be carried anywhere and does not require a large space, because this media is in the form of an application that is stored in a smart phone. The more sophisticated the level of specifications on the smart phone, the easier it is to use Android-based comic media. Screen brightness and screen size. The appearance on the smart phone that is owned can affect the user's comfort in reading comics. This media can be used by everyone, generally starting from junior high school students onwards. This media is very practical and can be carried everywhere and can be used in various places. In addition to having sophistication and strength as well as various other supporting factors.

The conclusions obtained from the results of research and development that have been carried out are as follows: 1. This media can be used as an alternative media from some of the limitations and difficulties faced by students at school. This media is equipped with attractive images and colors as well as unique characters, besides that it is packaged in the form of an application on Android that is easy to carry anywhere, thus making it easy for users or readers to apply and understand the content of the story. 2. The development of this android-based comic media refers to the results of validation by experts to see the eligibility criteria and obtained an average score from material experts of 79.62%, with a decent category. While the average score of the assessment results from media experts is 81.7%, and the media is categorized as very feasible to use.

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