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# Science Augmented Reality Program Media for Elementary School Students

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***ABSTRAK***

*Media yang dirancang dengan baik dalam batas waktu tertentu dapat merangsang munculnya dialog internal pada diri siswa. Salah satu media menarik yang dapat digunakan untuk meningkatkan motivasi dan semangat belajar siswa adalah media Augmented Reality (AR). Penelitian ini bertujuan untuk mengembangkan media Science Augmented Reality Program (SARP) dalam membantu proses pembelajaran pada siswa sekolah dasar. Penelitian ini menggunakan metode four-D. Data penelitian meliputi hasil validitas dan efektivitas penggunaan media Science Augmented Reality Program (SARP). Subjek penelitian dalam penelitian ini adalah siswa kelas IV Sekolah Dasar. Validitas meliputi validitas bahan ajar, validitas desain, dan validitas media pembelajaran dari dua ahli. Sedangkan uji efektivitas dilihat dari hasil uji coba terbatas dan uji coba lapangan. Produk diujicobakan pada siswa kelas VI SD pada materi IPA. Hasil penelitian menunjukkan bahwa persentase hasil uji validitas materi pembelajaran sebesar 95% dengan kategori sangat valid, persentase hasil uji validitas desain media pembelajaran sebesar 97% dengan kategori sangat valid, persentase hasil uji validitas media pembelajaran sebesar 92%. dengan kategori sangat valid. Secara keseluruhan dapat disimpulkan bahwa media Program Science Augmented Reality sangat cocok dan efektif untuk diterapkan sebagai media pembelajaran IPA di sekolah dasar.*

**ABSTRACT**

Well-designed media within a certain time limit can stimulate the emergence of an internal dialogue in students. One of the interesting media that can be used to increase students' motivation and passion for learning is Augmented Reality (AR) media. The aims of this study was to develop the Science Augmented Reality Program (SARP) media in assisting the learning process for elementary school students. This study applied the four-D method. The research data included the results of the validity and effectiveness of using the Science Augmented Reality Program (SARP) media. The research subjects in this study were fourth grade elementary school students. Validity includes the validity of learning materials, the validity of design, and the validity of learning media from two experts. Meanwhile, the effectiveness test was perceived from the results of limited trials and field trials. The product was tested on sixth grade elementary school students on natural sciences material. The results showed that the percentage of learning material validity test results was 95% with a very valid category, the percentage of learning media design validity test results was 97% with a very valid category, the percentage of learning media validity test results was 92% with a very valid category. Overall, it is concluded that the Science Augmented Reality Program media is very suitable and effective to be applied as natural science learning media in elementary schools.

## 1. INTRODUCTION

Education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble character, skills needed by themselves and society (Johnes et al., 2017; Maison et al., 2020; Yang et al., 2018). The learning process is an activity where there is a process of educative interaction between teachers and students by utilizing learning media so that the learning process can be carried out optimally (Gagne, 1996; Smaldino et al., 2008). The success of the learning

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process is affected by some factors including teachers, students, media, and the environment (Al-Maroof & Al-Emran, 2018; Saputro & Saputra, 2015). Learning media has an important influence on fostering the creativity of teachers and students in utilizing educational technology to improve the quality of education and meet the demands of educational technology developments (Antara & Dewantara, 2022; Bronack, 2011; Rizaldi et al., 2020). The development of educational technology brings convenience in the learning process which allows a change in learning orientation from what was originally only the presentation of knowledge from one party, to a process of interaction between two parties, namely teachers and students (Hettinger et al., 2021; Islam et al., 2022; Setyawan & Fatirul, 2019). Well-designed media within a certain time limit can stimulate the emergence of an internal dialogue in students. In other words, there will be communication between students and the media or indirectly between students and the source of the message and the teacher (Elkordy, 2016; Islam et al., 2022; Mufarizuddin., 2018). One of the interesting media that can be used to increase students' motivation and passion for learning is Augmented Reality (AR) media. Students who only learn science by reading materials and lectures from the teacher will not achieve maximum results. It is different when the students a read book which displays the visualization of the solar system in 3D images similar to the actual solar system. The book will greatly facilitate children in increasing mastery of concepts and a deep impression of how the solar system works (Guntur et al., 2020; Huh et al., 2020; Vagg et al., 2020). New innovations, especially in the use of technology and media development, are needed to increase the success of the learning process. Technology is a means that allows the creation of the necessary learning environment where the learning process can be realized in the most effective way (Kiryakova et al., 2018; Novitasari, 2019; Wakid et al., 2020). By looking at students' cognitive development, the development of Augmented Reality (AR)-based media will be preferred by students in understanding abstract concepts in the learning process (Del Cerro Velázquez & Méndez, 2021; Ritter, 2012; Sirakaya & Cakmak, 2018). Augmented Reality (AR) is a technology whose effectiveness can be seen significantly in the field of education and provides more meaningful learning by combining digital objects to create reality in the real world (Azuma, 1997; Billinghurst et al., 2014; Bistaman et al., 2018). Augmented Reality (AR) can combine two-or three-dimensional virtual objects into a real environment and then display or project them into a real form in real time. In learning natural sciences, elementary school students cannot visualize virtual objects or images on some science materials in a real environment because they are still in the concrete operational stage who can only understand real things in their environment. Virtual objects that cannot be seen in the real environment can be visualized by integrating graphics and computer technology and visualization technology. Elementary school students have difficulty in visualizing abstract science material concepts. Augmented Reality (AR)-based learning media can attract attention and be easily accepted by students in elementary schools (Alkhattabi, 2017; Flores-Amado et al., 2020; Kusdiyanti et al., 2020). Augmented Reality (AR) technology can increase learning motivation, learning experiences, and collaboration between students in elementary schools (Arici et al., 2019; Bistaman et al., 2018). Thus, it can increase students' interest in learning and have a high sense of curiosity in learning. By showing the results of the validation and feasibility of Augmented Reality (AR)-based media, it is very good and suitable to be used as a learning medium (Al-nawaiseh, 2020; Blevins, 2018; Peterson et al., 2020). From the above research results, it is shown that the development of Augmented Reality (AR)-based learning media is very much needed by teachers and students in the learning process. Several previous studies have developed an interactive augmented reality system for enhancing library instruction in elementary schools, moreover using augmented reality technology in storytelling activities to examine elementary students' narrative skills and creativity (Chen & Tsai, 2012; Yilmaz & Goktas, 2017). The two studies focused on literacy or language skills, while on science material there were also several augmented reality-based media developments. Among them is the augmented reality technology developed to improve students abstract reasoning in science learning (Sahin & Yilmaz, 2020; Syawaludin et al., 2019). Some of these developments focus on the effectiveness of use, while the development process through development methods has not been explained in detail. Then, in this case the research was conducted to develop the Science Augmented Reality Program (SARP) with the ADDIE method stages. It is hoped that this media can be an alternative solution in solving various obstacles in learning science for elementary school students.

## 2. METHOD

The development of Media Sciences Augmented Reality Program (SARP) applied the "4-D" model (Choirun & Anggana, 2014; Rizki & Linuhung, 2017). The 4-D development model has four main stages, namely Define, Design, Develop, and Disseminate. Define stage aims to determine and define the requirements needed in media development. This stage consisted of four activity steps including preliminary analysis, student analysis, curriculum analysis, and material analysis. In the early-late

analysis, the basic problems needed in the development of learning media appeared. In the student character analysis stage, the researcher conducted an analysis related to the character of the sixth-grade students in the second semester who were planned as the research targets. Character means cognitive development and the use of technology, especially mobile phones in learning. At the curriculum analysis, the researchers identified the main concepts and systematically arrange and relate one concept to other relevant concepts. At the material analysis stage, the researchers identified the main skills to be taught and broke them down into sub-skills. Material analysis is a collection of procedures to find content in learning that is carried out to detail the content of teaching materials in an outline according to the 2013 Curriculum. The series of curriculum and material analysis is the basis in setting learning objectives that are adapted to the use of the Science Augmented Reality Program (SARP) media. Design stage is carried out to design the Science Augmented Reality Program (SARP) media. At this stage, the researcher prepared the design of markers and the design of building applications consisting of interface design and AR menu design. The result of this design was a product design which was continued with validity by experts. Develop stage aims to produce a valid and effective Sciences Augmented Reality Program (SARP) learning media, so that the media can be used to help students learn about the solar system material. At this stage there were two tests which described as follows: (1) expert validity test which included learning material expert test, learning design expert test, learning media expert test, (2) Sciences Augmented Reality Program (SARP) media trial which included limited trials and field trials. In disseminate stage, the researchers limited the development of SARP to the socialization stage through limited distribution to teachers. Distribution is intended to obtain responses, feedback on the developed learning media. If the response of the target user of learning media is good, it will be distributed in large quantities so that the learning media can be used widely. The research subjects in this study were fourth grade elementary school students. In the media trial, the Sciences Augmented Reality Program (SARP) was limited to 10 students and in the field trial, 28 students in one class were involved. The data involved the results of the validity and the effectiveness of the Sciences Augmented Reality Program (SARP) media which were perceived through student responses after the trial. The variables, data, instruments, and analyzes used in this study are presented in Table 1.

**Table 1.** Variable, Data, Instrument, and Analysis

| Variable | Data | Instrument | Analysis |
|---|---|---|---|
| The Validity of Media | Material Validation Results | Validation sheet | Description of validity criteria |
| | Media Validation Results | Validation sheet | Description of validity criteria |
| | Design Validation results | Validation sheet | Description of validity criteria |
| | Validity level | Scoring Rubric | Validity Description |
| The Effectiveness of Media | The percentage of students' responses in a limited trial | Students' responses questionnaire | Description of Students' Responses |
| | The percentage of students' responses in a field trial | Students' responses questionnaire | Description of Students' Responses |

## 3. RESULT AND DISCUSSION

### Result

*Description of the Development of Sciences Augmented Reality Program (SARP) Media*

The development of AR-based media products for fourth grade elementary school students produces an android application "Sciences Augmented Reality Program (SARP)" accompanied by teaching materials and marker card posters. Figure 1 is a display of the Sciences Augmented Reality Program (SARP) media. Sciences Augmented Reality Program (SARP) media is an android application which must be installed beforehand on an android smartphone and used together with teaching materials or marker card posters. A poster of the Sciences Augmented Reality Program (SARP) media marker is show in Figure 2.


**Figure 1**. The Product of Sciences Augmented Reality Program (SARP)


**Figure 2**. Marker Posters of Sciences Augmented Reality Program (SARP)

*The Validation Results of Sciences Augmented Reality Program (SARP) Media*

Before testing the use of media, the media had to be validated by experts. The stages of validation of the Sciences Augmented Reality Program (SARP) media were carried out so that the media developed could be valid based on learning material experts, learning media design experts, learning media experts. Material expert validation was carried out by two experts who were competent with natural sciences subject, especially for elementary school students. Table 2 shows the results of material expert validation.

**Table 2.** The validation results of material experts

| Aspects | Criteria | Score | |
|---|---|---|---|
| | | Expert 1 | Expert 2 |
| Materials | Materials | 4 | 4 |
| | Contents | 4 | 4 |
| | Language Usage | 3 | 4 |
| **The Percentage of Material Expert Validation** | | **95%** | |

Base on Table 2, the results of the material expert validation were 95% with a very valid category. Good learning material is material that contains relevant material and content in accordance with core competencies and basic competencies in the applicable curriculum and the use of language adapted to the stages of students' cognitive development so that the material can be easily understood. The design validation was carried out by two experts who were competent in the field of information and technology based on interactive learning media, especially android-based. The results of the validation of learning media design experts is show in Table 3.

**Table 3** The validation results of material experts

| Aspects | Criteria | Score | |
|---|---|---|---|
| | | Expert 1 | Expert 2 |
| Learning Media Design | Media content quality | 4 | 4 |
| | Ease of application | 4 | 4 |
| | The suitability of the marker with the appearance of the application | 4 | 4 |
| | Media display | 4 | 3 |
| Percentage of Validation of Learning Media Design Experts | | 97% | |

Base on Table 3, the results of the design expert validation obtained the percentage of 97% with a very valid category seen from four categories, including: quality of media content, ease of application, suitability of markers with application display, and display media. The validation of learning media

experts was carried out by two experts who are competent in the field of interactive learning media and learning strategies. Learning media validation test results is show in Table 4.

**Table 4.** Learning Media Expert Validation Results

| Aspects | Criteria | Score | |
|---|---|---|---|
| | | Expert 1 | Expert 2 |
| Learning Media Design | Media quality | 4 | 3 |
| | Media technical quality | 3 | 4 |
| | Media display | 4 | 4 |
| Percentage of Validation of Learning Media Experts | | 92% | |

Base on Table 4, the results of media expert validation obtained the percentage of 92% with a very valid category seen from three categories, including: media quality, media technical quality, and the appearance of learning media.

*Effectiveness of Media Sciences Augmented Reality Program (SARP)*

The effectiveness of the Sciences Augmented Reality Program (SARP) as natural sciences learning media in elementary schools can be perceived from the results of students' responses in the form of questionnaires which were carried out with limited trials and field trials. The limited trial conducted to measure the effectiveness of the Sciences Augmented Reality Program (SARP) media. It was tested on 10 students in one class and the results can be perceived in Table 5.

**Table 5.** The Results of Limited Trial

| No | Criteria | Average Score |
|---|---|---|
| 1 | More interesting and not boring | 4 |
| 2 | Can create a more pleasant learning atmosphere | 3 |
| 3 | Encourages me to be enthusiastic about studying the material of the Solar System | 4 |
| 4 | Encourages me to cooperate with friends in completing assignments in groups | 3 |
| 5 | Encourages me to actively ask things that are still unclear to the teacher | 4 |
| 6 | Encourages me to understand the material better | 4 |
| 7 | Encourages me to get maximum learning results | 4 |
| 8 | Suitable for studying the material of the Solar System | 4 |

Base on Table 5, the results of the limited trial showed that the percentage of student response questionnaire results was 94% with a very good category perceived from eight criteria. After a limited trial was conducted, a field trial was conducted with a larger number of students, namely 28 students. Table 6 shows the results of the analysis of student responses in field trials.

**Table 6**. Field Trial Results

| No | Criteria | Average Score |
|---|---|---|
| 1 | More interesting and not boring | 4 |
| 2 | Can create a more pleasant learning atmosphere | 3 |
| 3 | Encourages me to be enthusiastic about studying the material of the Solar System | 4 |
| 4 | Encourages me to cooperate with friends in completing assignments in groups | 3 |
| 5 | Encourages me to actively ask things that are still unclear to the teacher | 4 |
| 6 | Encourages me to understand the material better | 4 |
| 7 | Encourages me to get maximum learning results | 4 |
| 8 | Suitable for studying the material of the Solar System | 4 |
| **The Number of Limited Trials** | | **30** |
| **The percentage of limited trial results** | | **94%** |

**Discussion**

The AR technology used to develop this media is a marker-based AR technology which means to see virtual objects in the form of 3D planet models. There must be a marker image object that is scanned using a smartphone camera. The marker image is called a target marker. The marker-based AR technology uses the designated objects to be displayed on layers to provide a different experience for students and teachers (Peterson et al., 2020; Sural, 2018). The development of technology-based media in the field of education is used to assist the learning process that can increase students' interest and motivation to better understand learning materials (Guntur et al., 2020; Sáez-López et al., 2020). Media based on the Sciences Augmented Reality Program (SARP) android application can be used by teachers and students as a medium for learning science in elementary schools. Augmented Reality (AR)-based media is able to present illustrations of three-dimensional learning materials so that visualization becomes more specific. Information in learning is clearer because it can combine the virtual world and the real world (Cholilah, 2017; Tegeh, I. M., Simamora, A. H., & Dwipayana, 2019). From the results of the validation test of learning media design, it is stated that the Sciences Augmented Reality Program (SARP) media is very valid to be used. Augmented Reality (AR) type technology is very suitable to be used as a learning medium for elementary school students (Ewais & Troyer, 2019; Gün & Atasoy, 2017; Hidayat et al., 2021). After testing the validity of learning materials, testing the validity of learning media designs, and testing the validity of learning media, it can be said that the Sciences Augmented Reality Program (SARP) media is very valid to be used as a science learning medium in elementary schools (MZ et al., 2021; Wityanita et al., 2019). The results of the field trial showed that the percentage of student response questionnaire analysis results was 97% with a very good category. It can be concluded that the learning process will be more effective and provide convenience for students to learn abstract material by using the Sciences Augmented Reality Program (SARP) media as a medium for learning natural sciences in elementary schools (Celik et al., 2020; Habig, 2020; Kusdiyanti et al., 2020).

These results are in line with several previous findings which state that augmented reality-based media has proven to be effective in helping students learn (Suryanti et al., 2020). In addition, other previous research is also state, in order to improve students' critical thinking skills. Then, in the context of science, media based on augmented reality has also been proven to be able to help facilitate students in learning (Hakim, 2018). In addition, this media also can support students' center learning. The implication of this research is to provide new information related to the application of augmented reality program science media for elementary school students. This information will be very helpful, especially for teachers at the elementary school level as a reference in implementing the learning process. Because as we know learning at the elementary level is very important and essential, so teachers must be able to implement effective learning. This study has several limitations, one of which is involving the subject which is still limited to 10 students and in field trials, 28 students in one class are involved. It is hoped that further research will be able to deepen and broaden the scope of research related to the use of Augmented Reality Programs for Elementary School Students.

## 4. CONCLUSION

The Sciences Augmented Reality Program (SARP) are valid and can be used as alternative media for learning science. This media is suitable for students in elementary schools. This can be proven by the results of the validity test of learning materials, the results of the validity test of instructional media designs, and the results of the validity test of learning media. The media is very effectively used for elementary school students as evidenced by limited trials and field trials conducted to measure students' responses. The media also support the learning process so that learning process becomes more meaningful.

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