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The Validity and Practicality of Augmented Reality-Based Media Development on Science Matter

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Abstract: Augmented reality is a learning media developed massively and utilized by educators to visualize abstract science concepts into concrete concepts. This study aims to analyze the validity and practicality of augmented reality-based media development on science matter to enhance science conceptual learning. This research is development research conducted to design products of learning media based augmented reality. The development model used is the Alessi and Trollip development model, which concentrates on augmented reality media development. The stage in this research, namely, planning stage, design stage and development stage. The data analysis technique used a questionnaire instrument and the technical descriptive statistical analysis. The results of this study are: the development of augmented reality-based learning media on water cycle and earth rotation material in the form of consisting of competencies and indicators, picture, sound, materials, and mini test; validity assessment by material experts with an average score of 94.44% in the "very valid" category, the validity assessment by learning media design experts with an average score of 95.83% in the "very valid" category; and the validity assessment by language experts with an average score of 80% in the "valid" category. The other results 95% of teacher responded positively to the questionnaire in the "practice" category. The results of this study indicate that augmented reality-based learning media can be categorized as valid and practice learning media.

Keywords: augmented reality, learning media, practicality, validity.

Abstrak: *Augmented reality menjadi salahsatu media pembelajaran yang telah dikembangkan secara massif dan dimanfaatkan oleh pendidik untuk memvisualisasikan konsep IPA yang abstrak menjadi konsep yang konkret. Penelitian ini bertujuan untuk menganalisis validitas media pembelajaran berbasis augmented reality pada materi siklus air dan rotasi bumi. Metode penelitian yang digunakan adalah model pengembangan dan penelitian oleh Allesi dan Trollip, yang berfokus pada pengembangan media pembelajaran. Data dikumpulkan menggunakan lembar validasi berupa kuesioner dan dianalisis menggunakan statistic. Adapun tahapan dari model pengembangan yang digunakan adalah tahap perencanaan, tahap desain dan tahap pengembangan. Dari hasil penelitian didapatkan bahwa pengembangan media pembelajaran berbasis augmented reality pada materi siklus air dan rotasi bumi terdiri dari kompetensi dasar dan indikator, gambar, suara, materi dan juga kuis, Validasi oleh ahli materi menghasilkan persentase sebesar 94.44% sengan kategori sangat valid, hasil persentase validitas oleh ahli media sebesar 95.83% dengan kategori sangat valid dan validasi oleh ahli bahasa dengan persentase 80% pada kategori valid. Hasil yang lain menunjukkan respon guru sebesar menunjukkan hasil kategori "praktis" category. Hasil ini menunjukkan bahwa media pembelajaran berbasis augmented reality dapat dikategorikan media yang valid dan praktis.*

Kata kunci: *augmented reality, media pembelajaran, praktis, validitas.*

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▪ INTRODUCTION

The era of technological advancement in the 21st century has become necessary for the general public, especially in education. The convenience offered by technological advancements has become a strong attraction for people to develop technology that benefits various aspects of life. Education is one of the aspects that utilizes technological development to ease learners in the learning process, namely through instructional media. Instructional media is one of the instruments that can support the creation of more effective learning (Ismail, Gumilar, et al. 2019). The use of instructional media can facilitate students in understanding of concepts, stimulate increased motivation, and enhance learner skills in a specific aspect (Salar et al. 2020).

In science education, instructional media plays a crucial role in assisting students in understanding the learning materials (Nor & Halim 2021). One of the goals of science education is to develop knowledge and understanding of science concepts that are useful and applicable in everyday life (Barrow et al. n.d.). Therefore, science education aims to develop knowledge and understanding of practical concepts in daily life. Conceptual understanding is an individual's ability to comprehend a concept. A student is said to understand a concept when they have grasped the meaning or significance of that concept (Wenfei et al. 2023) Students can also explain a phenomenon using their own words (Nasir, & Fakhruddin 2023).

Several topics covered in the science subject for elementary school students, such as natural events, states of matter and their changes, the water cycle, and Earth's rotation and revolution, require clear visualization. Based on previous research, students are not actively involved in transforming knowledge into understanding. They are only assigned homework tasks without being given a process to comprehend the taught materials. The availability of instructional media is still limited, mainly consisting of essential resources. As a result, the majority of students find it challenging to understand the subject, especially when it comes to science topics.

Based on the findings was discovered that in their case study, there was a problem where students needed help visualizing abstract concepts. Regarding this issue, "The constraints identified through the research affect students' ability to understand the material, causing frustration in building mental models, tending to be boring, thus adversely affecting their learning outcomes (Firmansyah et al. 2020). Based on these findings, it is deemed necessary to provide visualization of difficult abstract concepts to students through animations, simulations, and virtual laboratories." Therefore, multimedia incorporating simulations, animations, and virtual laboratories can address this problem (Ismail, Festiana, et al. 2019). This is believed to provide a comprehensive understanding of concepts to students, as suggested by the thoughts and findings the other research that "In practice, the use of multimedia technology applications can help students deeply understand the taught material and overcome limitations of space, time, and equipment (Sari et al. 2023)."

One instructional medium that can be used to enhance students' understanding of science concepts is Augmented Reality. Media that assist students in visualizing spatial concepts in three dimensions by manipulating two-dimensional or three-dimensional virtual objects into the real-world environment in real-time is referred to as Augmented Reality (Savitri & Meilana 2022). The advantage of augmented reality lies in its ease of

development and cost-effectiveness, enabling it to spread rapidly across various fields and be widely accessible through various media (Zuleni & Marfilinda 2022).

The research was titled "Augmented Reality in Elementary School Students Science Education and found that students' response to using this media in education was excellent (Pratiwi, Gunawan, & Ermiana 2022). Additionally employed technological-based learning environments in their research, focusing on the excretory system with traditional games during the pandemic. They discovered that learning through traditional games also undergoes changes as technology-based multimedia evolves. Based on the description above, it can be effective, information can be conveyed accurately, and learning becomes more engaging and innovative (Zuleni & Marfilinda 2022).

Research on augmented reality learning media. Media experts and subject matter specialists deemed this media's development suitable. Furthermore, considering the opinions of AR media teachers, this mobile learning approach was found to be more effective and practical. Based on field tests, this media was more accessible for students to understand as it allowed the visualization of all-optical instrument materials (Huda & Sulisworo 2016). An Android-based printed book on gas kinetic theory. The developed media achieved high percentages regarding motivation, content suitability, and skills (Bakri, Ervina, & Muliyati 2019).

The positive impact of using AR, which includes making learning enjoyable, enhancing student engagement, increasing student motivation, facilitating collaboration among students, providing feedback, and boosting student creativity. Augmented reality (AR) is considered a valuable educational tool, especially for students with complex physics concepts (Hiranyachattada and Kusirirat 2020). AR merges the real and virtual worlds by integrating computer-generated interfaces, creating a seamless interaction between the two realms (Prahanı et al. 2022; Akçayır, M., et al., 2017). In simple terms, AR superimposes virtual objects onto the natural environment. Previous research has explored various AR applications, including gaming formats (Chen and Tsai 2012) and interactive books (Hwang et al. 2016). Marker-based AR can be divided into image and location-based and can be implemented on desktop or mobile platforms (Amin et al. 2021). Numerous studies have investigated the impact of AR on learning, revealing positive outcomes such as improved understanding of topics like electricity, enhanced laboratory skills, more positive attitudes towards physics labs, increased motivation in computer-based learning, and easier comprehension of abstract concepts (Theodoropoulos & Lepouras 2021).

Based on the literature and background above, the researchers developed augmented reality-based learning media to improve elementary school students' understanding of concepts in science materials. The purpose of this study is to explain and represent the development of valid augmented reality-based learning media on science material.

▪ METHOD

Research Design and Procedures

This research is development research conducted to design products of learning media based augmented reality. The development model used is the Alessi and Trollip development model, which concentrates on augmented reality media development. The procedure of development research followed by the figure below.

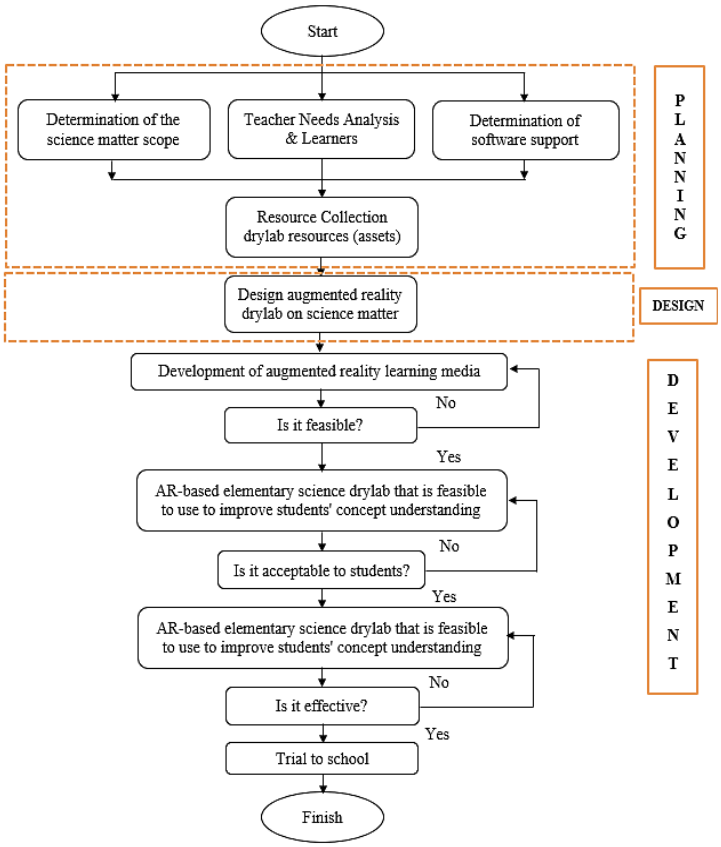

Figure 1. The procedure of alessi & trollip model development (Alessi & Trollip, 2001)

The first stage is planning phase. This planning stage contains explanations and plans for the product description to be developed. The planning stage consists of 10 sub-components, namely: a) define the scope, b) identify learner characteristic, c) establish the constraints, d) cost the project, e) produce a planning document, f) produce a style manual, g) determine and collect resource, h) conduct initial brainstorming, i) define the look and feel, dan j) obtain client sign-off. At this stage, the initial activity carried out in the research is to identify the scope or analyze the availability of learning resources in elementary schools, the expected output, and the competencies to be achieved. Furthermore, to make a well-thought-out plan, it is necessary to identify the characteristics of the learners in terms of who they are, their initial abilities, perceptions, difficulties encountered, and the level of understanding of the material to be developed. The initial characteristics of learners include motivation to learn, access to learning resources, domicile of residence measured by distance from the center of education, available communication channels and media, discipline in managing time, systematic learning habits, and time, systematic learning habits, and learning habits in thinking about the application of the material learned. The planning stage also formulated the program display plan and material content as prototypes.

The second stage is design. This stage consists of 7 sub-components, namely: a) develop content ideas, b) conduct task and concept analyses, c) do a preliminary program description, d) prepare prototype, e) create flowcharts and storuboards, f) prepare scripts, dan g) obtain clinet sign-off. One of the activities at this design stage is carrying out task

and concept analysis. The result of this design stage is a flowchart that will determine the sequence of material, develop a storyboard, and determine the supporting sources (script, video, audio, etc.) needed.

The development stage is the pouring of the design concept into being a mature product. The sub-components in this development stage consist of 2 sub-components, namely: a) prepare the text, b) write program code, c) create the graphic, d) produce audio & video, e) assemble the piece, f) prepare support materials, g) do an alpha test, h) revise, i) do a beta test, j) make final revisions, k) obtain client sign-off, and L) validate the program.

Population and Sample

Research population was students in Islamic Elementary School in Palembang, South Sumatera province. The samples were taken by using cluster random sampling, and each level classroom consisted of 3 students. The total sample was 18 students to try the augmented reality learning media.

Instruments

The qualitative analysis of gathering research information involved using various instruments throughout different phases of the research. These instruments, for each stage, included creating a questionnaire with a list of questions for observation. The development and expert validation of these tools utilized a Questionnaire from Learning Instruments, a Likert scale. Research data was collected through module validation using validation sheets by educational experts and practitioners in the field. Validation analysis was carried out using a Likert scale. The validators who validate augmented reality media are content expert validators, media expert validators, and language expert validators.

Data Analysis

Data analysis techniques are carried out to process data obtained during the evaluation period using predetermined instruments. The data analysis used in this study is an alpha test data analysis for feasibility, referring to the evaluation according to Alessi and Trollip, with the answer categories acceptable and needing improvement (Alessi, S. M., & Trollip, S. R. 1984). Trollip with the answer categories is acceptable and needs improvement. The feasible category in the research method used, namely Alessi and Trollip, will be achieved if all aspects on the instrument have reached achieved if all aspects of the instrument have reached 100%. This aspect means that the validation instrument is acceptable. If aspects require improvement, then the aspect will be corrected until it is declared feasible by the experts concerned.

The data analysis stage carried out are the validity test and the practicality test. Data analysis in this study in detail is represented in Table 1.

Table 1. Variables, required data, instruments, and data analysis

Variables	Required Data	Instruments	Data Analysis
Validity	Content, language, and media validation data results	Content, language, and media validation sheet	Descriptive statistics, percentage technique
Practicality	Student responses	Response questionnaire	Descriptive statistics, percentage technique

▪ RESULT AND DISSCUSSION

The science material used in developing augmented real-based learning media is 5th grade material, namely on the sub-theme of the water cycle, and 6th grade material on earth rotation. Increased reality media helps students explain the process of the water cycle and earth rotation, which has been presented through 2 dimensions, changed and developed in 3-dimensional form, and has animation and background. Product development is developed through three stages, namely, planning, design, and development. The process and results of each step can be explained below.

Planning Stage

In the planning stage, researchers made initial observations of teachers and students by analyzing the needs of learning media observed through the interview process and distributing questionnaires. Based on the words and questionnaires, that teachers know what augmented reality-based learning media looks like 57%, 47% of teachers see the role of increased reality learning media, and 23% know the types of augmented reality (AR) media. Based on the research results, teachers positively respond to the need for increased reality-based learning media. After that, the researcher executed to determine the problems that would be overcome using the augmented reality learning media. The formulation of the issues compiled in this study are: 1) how to develop augmented reality learning media in 5th grade and 6th grade that is valid and practical? 2) How is the use of augmented reality-based learning media to improve elementary school students' concept understanding of science materials?

The next step is to discuss with the team the augmented reality media to be developed and to predict the weaknesses of the press to be developed and predict the problems that may arise. After determining this, researchers began to provide an initial description of the augmented reality media display plan to be designed and select the software to be used. The software used in this research is Assemblr edu.

Hidayat, Sukmawarti, and Suwanto (2021) on their research on the use of Assemblr Edu augmented reality media in improving understanding of the concept of blood circulation. The study was conducted on grade VIII students. The results showed that students were more able to understand the subject matter provided due to the use of relevant images, as stated in the textbook, but the photos could move, which made them look more alive. Students feel impressed and happy in learning using the media, so there is a higher student learning motivation, and this can have an impact on students' knowledge, skills, and attitudes, which also increase.

Design Stage

At this stage, it combines science material content and learning media design to produce an augmented reality media prototype. At this stage, the analysis of science concepts developed into increased reality media content has been carried out. Based on the results of the study, the material chosen was grade 5 on the subtheme of the water cycle and grade 6 on the subtheme of the earth's rotation. The results of initial observations made by one of the elementary schools in Palembang city show that students need more understanding in science learning, so students have yet to be able to identify the process of earth rotation and the water cycle. This is also supported by previous

research, which states that several factors influence students' low understanding ability, one of which is the ability to solve problems memorized without understanding the material correctly in science subjects (Hwang et al. 2016).

Development Stage

This development stage begins with preparing the text in the media, creating graphic designs with Assemblr edu software.In addition, the development carried out to include sounds and videos in the media can make the media more attractive and able to attract more students' attention and unite the pieces that have been made into one to see harmony in the preparation of interactive multimedia programs.

This stage also prepares additional materials, such as instructions for using augmented reality learning media. Initial trials will involve expert validators to provide assessments, comments, and suggestions to produce valid learning media. The next step is to make revisions according to the evaluations given by expert validators and then conduct trials involving students to see the level of practicality of the augmented reality learning media that has been developed. The following are the results of development on the material of the water cycle and earth rotation through images 1 and 2.

Figure 1. Augmented reality learning media on water cycle

Figure 2. Augmented reality learning media on earth rotation

After the prototype of augmented reality media on the material of the water cycle and earth rotation is available, the researcher validates the expert validator. The aspects validated in this media are content (science material), language, and learning media design. The following is an assessment of each expert validator on augmented reality-based learning media.

Learning Design Media Expert Validation

The evaluation for the validation of material experts comprises three main components: presentation of learning materials, media suitability dan student engagement in media using. Validation results from material experts is an average score of 3.9 or 95.83% placing it within the excellent category. The each of aspect consists presentation of learning materials as many as 3.86 or 96.5%, media suitability with percentage 100% and student engagement in media use with 3.6 or 90%

Based on the final assessment score obtained from the results of the linguist validation test, the percentage value is 95.83%, with a very valid category. By the validation criteria used in the expert validation table, if the score obtained is 86% ≤ HVA ≤ 100%, then the media is declared very valid for use.

Material Expert Validation

The assessment for material expert validation consists of 3 (three) aspects, namely, curriculum, learning process, material, and interaction. The value obtained from the validation of material experts with an average acquisition value of 3.8 or 94.4%, the acquisition of this value is included in the excellent category.

The aspect consists of material as many as 93.75%, learning process with percentage 100%, curriculum as many 92.5% and interaction aspect with 87.5%. Based on the final assessment score obtained from the results of the linguist validation test, the percentage value is 94.44%, with a very valid category. By the validation criteria used in the expert validation table, if the score obtained is 86% ≤ HVA ≤ 100%, then the media is declared very valid for use.

Language Expert Validation

Validation from language experts is divided into Readability of materials, symbols and language use in the media. From the validation of learning media experts, it gives an average score of 3.2 or 80% and is included in the good category. The evaluation of language experts is shown 85% with readability of material aspect, readability of symbol 100% and percentage use of standardized language as many as 80%.

Based on the final assessment score obtained from the results of the linguist validation test, the percentage value is 80% with a valid category. By the validation criteria used in the expert validation table, if the score obtained is 70% ≤ HVA ≤ 86%, then the media is declared valid for use. The validation results of learning design experts, material experts, and language experts are shown in Table 1.

From the data above it can be seen that the validation results of learning design media experts are 95.83% in the very valid category, material experts are 94.44% in the very valid category and language experts are 80% in the valid category, this proves that augmented reality learning media suitable for use in elementary level.

Practicality of the Ongoing Augmented Reality Learning Media

The practicality of the augmented reality learning media was determined based on the student responses to the ongoing learning media used in the study of water cycle and earth rotation. Student responses to ongoing learning media are shown in figure 3.

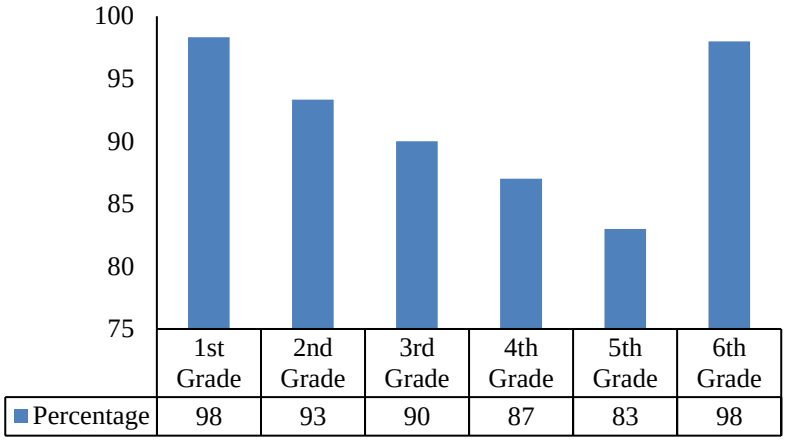

Figure 3. Student's responses to ongoing learning media

The diagram above shows that the responses of grade 1 to grade 6 students strongly agree on the use of augmented reality learning media as an alternative learning media in the classroom through science learning. The findings from the initial trial of augmented reality learning media, which utilizes Augmented Reality, reveal that 90% of students responded positively to the questionnaire. This percentage classified 'very good'. A small-scale field trial involving 18 students was conducted following the limited trial. The results of this field trial indicate 94% positive response rate on the questionnaire, also classified as 'very good.' These results suggest that using this learning media in the learning process enhances effectiveness, particularly in understanding abstract concepts, and simplifies the learning experience for students.

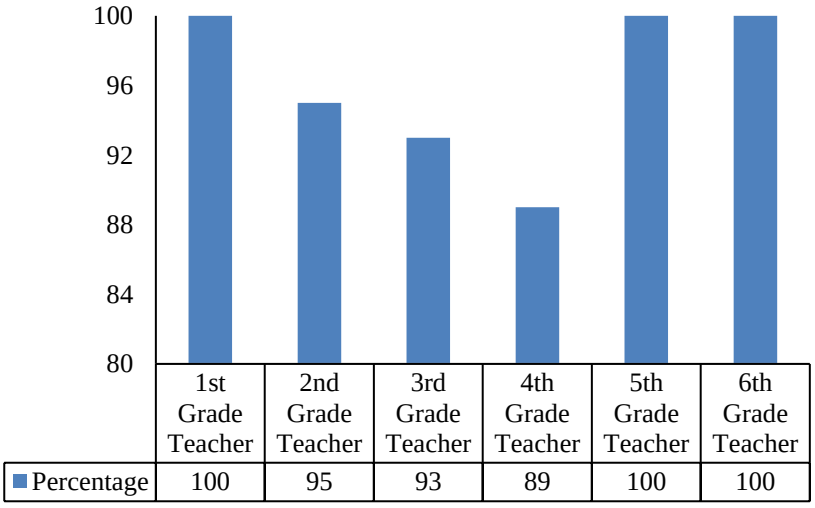

Figure 4. Teacher's responses to ongoing learning media

The diagram above shows that the responses of 6 teacher strongly agree on the use of augmented reality learning media as an alternative learning media in the classroom through science learning. Based on diagram, the results 95% of teacher responded positively to the questionnaire. This percentage classified 'very good'. These results suggest that using this learning media in the learning process enhances effectiveness, particularly in understanding abstract concepts, and simplifies the learning experience for students.

Previous research states that the advantages of using augmented reality as a learning medium have been proven with augmented reality that the advantages of using augmented reality as a learning medium have been proven through several studies, including an increase in achievement and positive attitudes in science learning (Chen, Ho, & Lin 2015; Cheng & Tsai 2016). Another research present that the results of this study indicate that augmented reality-based learning media on hydrocarbons is very suitable for use in learning and has been proven to increase students' conceptual (Ningrum, Sumarni, and Cahyono 2021).

Regarding the technology used in developing learning media, only a few science teachers have known and understood the concept of augmented reality learning media. This shows that very few teachers still use and even develop augmented reality multimedia in delivering science concepts in the learning process. One of the benefits of using augmented reality learning media is that it makes it easier for students to learn science concepts. A few research findings show that the utilization of Augmented Reality (AR) in education can have beneficial effects. These benefits manifest in improved educational outcomes, attitudes, motivation, concentration, and memory during the learning experience (Sahin and Yilmaz 2020; Kamarainen, A., et.al., 2018).

Teacher at learning process use several learning media to facilitate the student. Educators must be able to utilize learning media so that the learning process does not experience difficulties, so efforts should be made to develop learning media to take advantage of the advantages of the press and avoid obstacles that may arise in the learning process (Maharuli, et al., 2021; Arslan, et.al, 2020). Based on the interview that using of canva and powerpoint is biggest percentage than another learning media. Of these types of media, the choice of using learning media must be adjusted to the conditions and achievement of learning objectives. The purpose of the conditions in selecting media is that they are in accordance with the current situation and in accordance with the abilities possessed by the students. So that the media that is broadcast or submitted can be processed properly and correctly.

The material that will be given or shown to students can be delivered through learning media. Because learning media is a supporting tool that makes it easier for educators to convey material. Media can be a supporting factor in student success (Silmi & Rachmadyanti, 2018). Based on the teacher's opinion that the role of learning media are helps them to achieve learning goal, motivate students to learn, accommodate different learning styles, visualizing abstract concepts, and presenting a diversity of learning resources. Learning media greatly influences student learning outcomes in science learning content. Apart from that, students also have different experiences in the learning process using media. This can also improve students' ability to understand lesson material easily through media during the learning process (Syawaludin and Gunarhadi 2019)

We asked other questions to teachers regarding the solutions offered if there needs to be adequate learning media to facilitate students. Several teachers answered that learning media that could be a solution was using teaching aids, contextual media, learning videos and concrete media. Previous findings show that the use of augmented reality in the learning process has a significant impact on improving vocabulary comprehension and learning achievement (Chou et al. 2022). Another study also confirmed that Augmented Reality (AR) media can significantly improve student learning outcomes, especially in cognitive aspects (Syawaludin 2019). In addition, AR media has also proven effective in improving the understanding for deaf children. In this study, of course, it still has limitations in the implementation of the stages. So that further research is still needed to see the effectiveness of augmented reality learning media to improve elementary students' understanding of concepts.

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▪ CONCLUSION

Based on the results of research, data analysis, and discussion, it can be concluded that the validity of augmented reality-based learning media on water cycle and earth rotation material is in very valid category. the validation results of learning design media experts are 95.83% in the very valid category, material experts are 94.44% in the very valid category and language experts are 80% in the valid category, this proves that augmented reality learning media suitable for use in elementary level. The other results 95% of teacher responded positively to the questionnaire. This percentage classified 'very good'. These results suggest that using this learning media in the learning process enhances effectiveness, particularly in understanding abstract concepts, and simplifies the learning experience for students.

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