EDUKASIA: Jurnal Pendidikan dan Pembelajaran
Vol. 5, 1 (June, 2024), pp. 2007-2018
ISSN: 2721-1150 EISSN: 2721-1169

Augmented Reality in Health Comics: GermBusters VR Media Development for Children's Health Learning in Elementary Schools

Lilik Bintartik[1], M. Anas Thohir[2], Dani Irawan[3], Khomsiyah Naili[4], Sabillatush Oktaviani[5]

[1] State University of Malang, Indonesia; lilik.bintartik.fip@um.ac.id
[2] State University of Malang, Indonesia; m.anas.tohir.fip@um.ac.id
[3] State University of Malang, Indonesia; dani.irawan.ft@um.ac.id
[4] State University of Malang, Indonesia; khomsiyah naili@um.ac.id
[5] State University of Malang, Indonesia; sabillatush oktaviani@um.ac.id

ARTICLE INFO

Keywords:

Augmented Reality (AR);
Health Comics;
Educational Media;
GermBusters VR

Article history:

Received 2024-09-02
Revised 2024-10-08
Accepted 2024-10-28

ABSTRACT

Augmented Reality (AR) technology has become an important innovation in the world of education, especially in increasing students' interest and understanding. This study aims to develop Augmented Reality-based health comics as educational media for children's health learning in Elementary Schools. This study uses the Research and Development (R&D) method with the ADDIE model. The subjects of the study involved two experts, three teachers, and 42 3rd grade students from three elementary schools in Malang City, namely SD Tunggulwulung, SD Kebonsari, and SD Sukun 2. Students were selected using purposive sampling techniques. Data collection techniques used questionnaires and assessment scales. Data analysis was carried out descriptively. The results of the study showed that: 1) at the design stage, an initial product of AR-based health comics was developed with the nameGermBusters VR; 2) the validation results from experts show that this product is very feasible to be used in health learning; 3) the teacher and student response questionnaires indicate that this AR-based comic is very practical and interesting to be used as a health learning medium.

Corresponding Author:
Lilik Bintartik
State University of Malang, Indonesia;lilik.bintartik.fip@um.ac.id

1. INTRODUCTION

Technology in education has developed rapidly in recent decades, especially with the emergence of digital technology-based innovations that facilitate access to information and learning. One innovation that has great potential to be applied in the world of education is Augmented Reality (AR) technology. This technology combines the real world with digital elements, creating an interactive experience that can stimulate students' interest and understanding more effectively. One promising application of AR is in educational media in the form of comics, especially in the field of health for elementary school children.

Comics have long been one of the media that children are interested in, because of their entertaining and easy-to-understand nature. In the world of education, comics are used as an effective tool in conveying complex information in a simpler and more interesting way. By utilizing AR technology, comics can be brought to life with interactive elements such as animation, sound, and visual features that make learning more interesting and interactive. This is especially relevant in health learning among children, who are generally more interested in visual and interactive content than plain text.

The Covid-19 pandemic has been one of the biggest challenges for education systems worldwide. Nearly 1.6 billion students in more than 200 countries have been affected by the closure of schools and educational institutions (De Vries et al., 2022). These closures have affected more than 94% of the world's student population, who have had to adapt to distance or online learning. Various studies have shown that this situation not only impacts the learning process, but also the moral and social development of students (Kairgozhin et al., 2023; Tsekhmister et al., 2024). One of the most affected aspects is academic integrity, which becomes even more important during online learning (Agusriani & Ramadan, 2024).

The decline in student integrity is a major concern during the pandemic. According to research by Gustilo et al (2024), in addition to its impact on the health and financial sectors, the pandemic also affects students' academic integrity. Online learning provides many opportunities for students to commit academic fraud, which can be done in various ways (Purwatmiasih & Oktavia, 2021). This is due to changes in student learning patterns, which have become more flexible and are not directly controlled by teachers (Tsakeni, 2021). Many students experience a decline in discipline and responsibility, both in attending lessons, submitting assignments, and in other matters (Ispas et al., 2022). Values such as honesty, discipline, and responsibility, which are representations of integrity, have decreased significantly during the pandemic.

According to Anggraena et al., (2022), integrity is a character value that underlies a person's behavior to always try to be trusted in words, actions, and work; and committed and loyal to humanitarian and moral values. In the context of education, integrity is very important to develop from an early age. Therefore, education must ensure that they not only excel academically but also grow into responsible and ethical individuals in society playing an active role in fostering an attitude of integrity in students (Kabra, 2022).

In addition to integrity, another problem that arose during the pandemic was the loss of learning, or what is known as learning loss. Research conducted by the Ministry of Education, Culture, Research, and Technology (Kemendikbudristek) shows that students in Indonesia experience significant learning loss, especially in literacy and numeracy (De-Graft & Asante, 2022). Research from UNESCO, UNICEF, and the World Bank also shows that the pandemic has caused a significant decline in students' reading ability, known as reading loss (Goldschmidt et al., 2024). This loss of learning ability is caused by students' inability to access face-to-face learning which is more effective than online learning (Zosh et al., 2024).

In the context of primary education, the learning loss that occurred during the pandemic was exacerbated when students returned to school (Ferrari et al., 2022; Ardington et al., 2021). Teachers faced the challenge of restoring students' learning abilities and ensuring that the learning loss did not have a long-term impact on their academic development. In addition, they were faced with the issue of students' social and emotional morality, which declined during distance learning (Muassomah et al., 2022). Teachers are now tasked with not only addressing academic gaps but also fostering a supportive environment that promotes emotional well-being and resilience among students.

Elementary school children, especially third graders, face major challenges in reading comprehension during the pandemic. Research by Madani et al., (2022) shows that third graders should be able to understand reading based on context, but due to learning loss, this ability is hampered. According to Taneri & Mutlu (2022), third graders are generally interested in simple stories that are

contextual to everyday life, especially those related to animals. However, due to limited face-to-face interaction during the pandemic, students have difficulty developing this contextual reading ability.

To overcome the problem of learning loss and decreased integrity, an innovative approach is needed that combines technology with educational media that is interesting for children. One approach that can be taken is through the development of AR-based health comics. These comics not only function as a medium to convey health information visually, but also as a tool to instill moral values such as honesty, discipline, and responsibility.

Salam et al (2018) stated that learning media plays an important role in stimulating student learning. In this context, AR technology can be used to stimulate children's interest in learning through interesting interactions. According to Karo-Karo & Rohani (2018), media is anything that can convey messages from the sender to the recipient so that it can stimulate thoughts, feelings, attention, and interests. Therefore, the use of AR technology in health comics can help students understand health material while fostering integrity through the moral stories presented. Previous research has also shown that fairy tales and stories conveyed through digital media can be effective tools in character education, including integrity (Muhtar et al., 2020).

By using multimedia technology, comics that combine AR can create a more interesting and effective learning experience for students, especially in learning health material that is often considered boring by children. In line with this trend, the development of AR-based health comics can answer the learning needs in the post-pandemic digital era. This media is not only relevant to current learning challenges, but can also be part of long-term efforts to improve the quality of education in Indonesia.

2. METHODS

The development method used is the ADDIE Model. The ADDIE model was chosen in developing this media because this model has been common and often used in developing media for learning and is widely known. As stated by Rahmawati et al (2024) listed ADDIE as one of the multimedia application development methods for CBT products. Furthermore, Drljača et al (2017) used the ADDIE model to produce Multimedia Applications, it was concluded that the ADDIE approach can be used to develop interactive multimedia applications that can support the learning process. The stages of ADDIE research and development are shown in Figure 1 as follows:

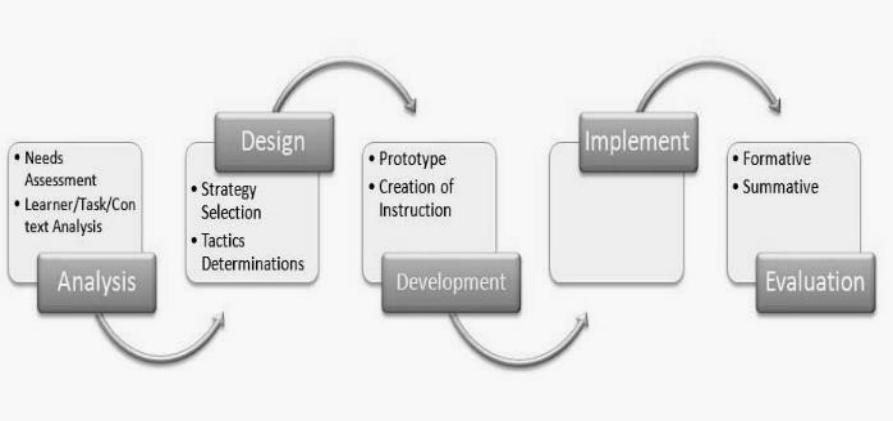

Figure 1 ADDIE development model

The subjects in this study were 42 third-grade students from three elementary schools in Malang City, namely Tunggulwulung Elementary School, Kebonsari Elementary School, and Sukun 2 Elementary School. In addition to students, this study also involved two experts, namely material experts and media experts, as well as three class teachers as assistants. The selection of subjects was carried out using a purposive sampling technique to ensure that students involved in this study represented various levels of intelligence, ranging from high, medium, to low intelligence. The involvement of teachers and experts aims to provide a comprehensive assessment of the quality and effectiveness of the learning media developed.

Table 1. Research Instruments

Data Name	Instrument Name	Indicator
Content Validity	Validation by Subject Matter Experts	a. Suitability of material with curriculum b. Quality of educational content c. Depth of information d. Clarity of learning objectives e. Accuracy of concept delivery
	Validation by Media Experts	a. Visual design b. Consistency of visual elements c. Text readability d. Use of color and images e. Media interactivity f. Compliance of audio-visual elements
Practicality of Use	Practicality by Students	a. Readability and understanding of content b. Convenience in using media c. Visual appeal d. Ease of accessibility of AR features e. Ease of use of technology
	Practicality by Teacher	a. Suitability of media to teaching methods b. Effectiveness in achieving learning objectives c. Influence on student learning motivation d. Practicality in classroom application e. Student interaction with media

In the data analysis process, descriptive statistical techniques were used to calculate the average of the expert validation scores, as well as the responses given by students and teachers. This process serves as an initial step to assess the feasibility and practicality of the media developed. Data collected in quantitative form was converted into qualitative data to provide a more easily understood picture of the aspects being assessed. Expert validation used a Likert scale with a value range of 4-3-2-1, where each item on the validation instrument was added up and accumulated, resulting in an average value. This average was then used as an indicator of feasibility based on aspects of learning materials and media in the table.

Table 2. Service Guidelines by Media and Material Experts

Score	Category
Value > 3.4	Very Worth It
2.8 < x ≤ 3.4	Worthy
2.2 < x ≤ 2.8	Quite Decent
x ≤ 2.2 + 0.2	Not feasible

Meanwhile, the practicality of teachers and students using the Gutman scale with scores of 0 and 1 and referring to the conversion table

Table 3. Guidelines for Converting Teacher and Student Response Data

Interval Score (%)	Category
76 ≤ x ≤ 100	Very Practical
51 ≤ x ≤ 75	Practical
26 ≤ x ≤ 50	Not Practical
0 ≤ x ≤ 25	Very Impractical

3. FINDINGS AND DISCUSSION

The product of this research is an interactive learning media based on Augmented Reality (AR) called "GermBusters". VR",aims to educate elementary school children about the habit of washing their hands and disposing of trash in its place. Based on an initial survey at SD Tunggulwulung, SD Kebonsari, and SD Sukun 2, it was found that children often do not understand the importance of washing their hands properly and disposing of trash in its place. This is exacerbated by the lack of educational media that is interesting to them, especially those that use an interactive visual approach. The development of this learning media was carried out by considering the results of interviews with teachers and students, where they emphasized the need for media that is not only informative, but also able to attract children's interest. The AR Health Comic was developed in a digital format that is accessed via smart devices, most of which are already owned by students and teachers. With the AR feature, this comic allows students to scan a specific page and see an animation or short video that demonstrates the correct way to wash their hands or the impact of littering.

The advantage of this AR Health Comic is its ability to provide a more in-depth and interactive learning experience. When students scan the page with the camera, the characters in the comic will come to life and provide direct instructions, for example on the steps for washing hands according to WHO recommendations. In addition, students can also see an interactive simulation of how waste that is not disposed of properly can pollute the environment. In the context of learning media, the use of AR technology provides an interesting alternative for teachers, because students not only read the material, but also interact with visual content that supports their understanding.

Figure 2. VR Comic Development Results

Figure 3. Results of Komi VR Development of Hand Washing Material

Figure 4. Results of VR Comic Development on the Material of Throwing Away Garbage

GermBusters VR has undergone validity testing by material experts and media experts, with very satisfactory results. Validation by material experts was carried out in two stages. In the final stage, GermBusters VR received a total score of 85 out of 20 items, with an average score of 4.25. This score indicates that the material in the application is in the "very feasible" category. Material experts concluded that the health education content in GermBusters VR was very good and did not require revision. On the other hand, validation by media experts was also carried out twice.

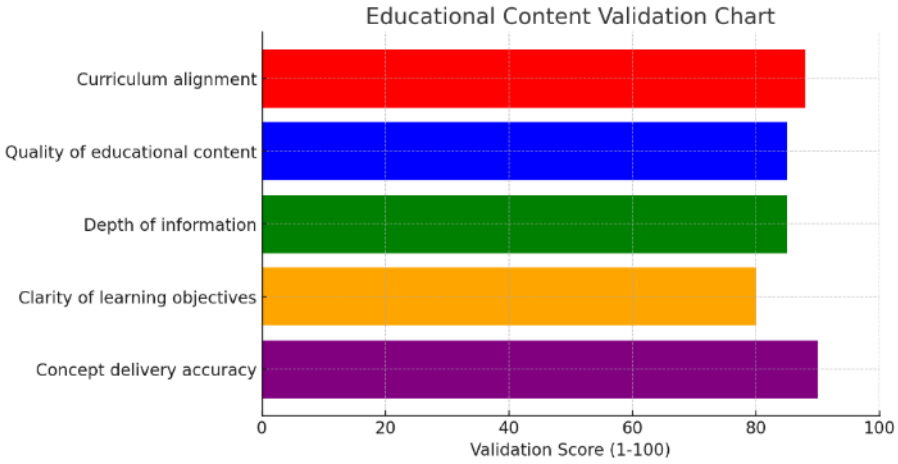

Figure 6. Validation of Material Experts

The final results showed a total score of 88 out of 22 items, with an average score of 4.0. This places the app in the “decent” category. Media experts praised the innovative VR interactive design and stated that GermBusters VR has met all the technical and visual standards necessary to provide an engaging and effective educational experience for students without the need for further revision.

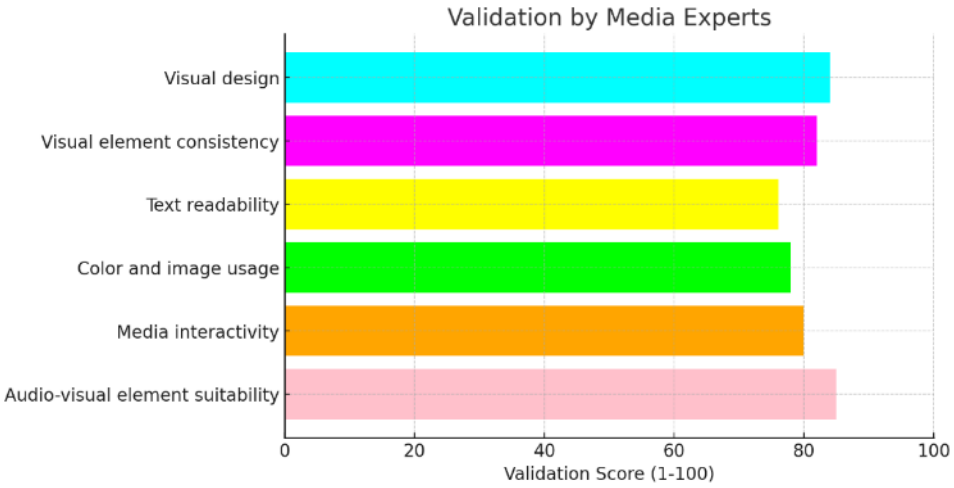

Figure 7. Validation by Media Experts

The results of the analysis of the validation practicality by media experts show that this AR-based learning media is very suitable for use by both students and teachers. From the student's perspective, the media scored high in content readability (88), comfort (85), visual appeal (90), ease of access to AR features (82), and use of technology (87). This shows that the media effectively supports students' understanding and learning comfort.

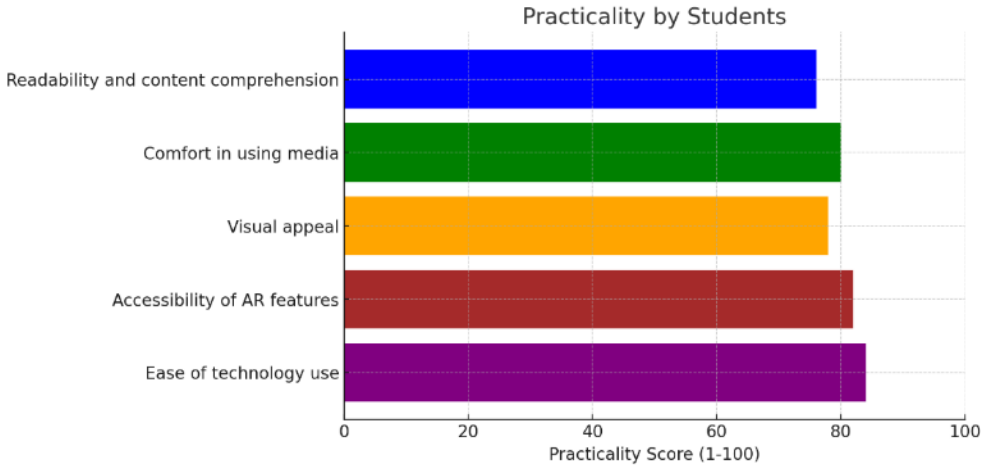

Figure 8. Practicality By Students

From the teacher's perspective, this media is considered very appropriate for the teaching method (92), effective in achieving learning objectives (88), and increasing student learning motivation (90). The aspects of practicality (85) and student interaction with the media (87) are also considered good. Overall, this media has proven to be feasible and practical to support an interactive and effective learning process.

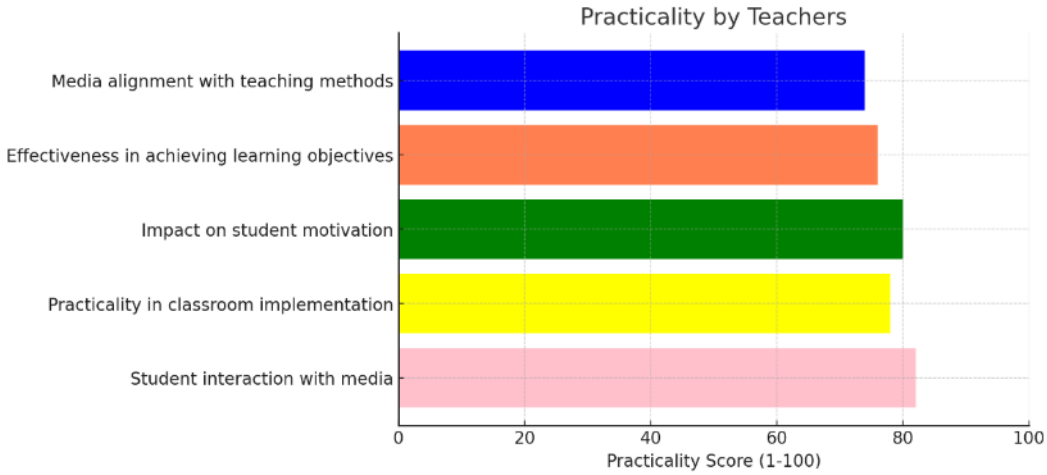

Figure 9. Practicality By Teacher

Based on this analysis, this learning media is very feasible to be used in the teaching and learning process. The feasibility aspect is supported by the suitability with the teaching method, learning effectiveness, and positive influence on student motivation. The practicality aspect from the perspective of teachers and students shows that this media facilitates the learning process interactively and efficiently, making it a very feasible media choice to be applied in the classroom.

Discussion

AR features in AR Health Comics allow students to scan a specific page and view an animation or short video demonstrating how to wash their hands properly and the impact of littering. This provides a more immersive and interactive learning experience. In this case, the use of AR in education can improve conceptual understanding, as interactive visual elements make information easier to digest (Devega et al., 2023). Another advantage of AR Health Comics is its ability to provide direct instructions as students interact with the content. For example, as students scan a page, characters in the comic can provide steps for washing their hands according to WHO guidelines. Interactive media can help students better understand the material, especially concepts that require in-depth visualization (Dewi et al., 2022).

In the context of learning, the use of AR technology provides an interesting alternative for teachers. This allows students to not only read the material but also interact with visual content that supports their understanding. Interaction with AR media can increase students' learning motivation, because they feel more involved in the learning process. (Buchner & Zumbach, 2018).

The results of the field trial showed that the AR Health Comic was effective in increasing students' awareness of personal and environmental hygiene. This media helps students understand the importance of washing hands and disposing of trash in a fun and interactive way. In addition, teachers found that this media made it easier for them to explain topics that might be considered boring through conventional methods. The use of interactive technology in teaching can increase student engagement and reduce boredom levels during the learning process (Fonseca & García-Peñalvo, 2019).

Thus, AR Health Comics are not only teaching aids, but also become a bridge that connects students with important information about health and hygiene. The development of this media creates a more dynamic learning space, where students can learn in a fun and effective way. Interesting and interactive media can encourage students to be more actively involved in learning, which ultimately contributes to improving their learning outcomes (Susila et al., 2019)

Feasibility of AR-Based Learning Media Based on Practicality by Students

Based on the findings of the research results, the Augmented Reality (AR)-based learning media developed was considered very feasible by students in various aspects. With high scores on readability and content understanding (88), comfort in using media (85), visual appeal (90), ease of accessibility of AR features (82), and ease of use of technology (87), this media has proven effective in supporting students' learning experiences. High readability assessments indicate that the content in this AR media can be well understood by students. AR-based media can improve students' understanding of learning materials by integrating visual and interactive elements that are easy for children to understand. (Irwansyah et al., 2017).

The convenience of using the media, which was assessed at 85, is also an important indicator that shows that the AR interface and navigation design are well designed. The convenience of AR media interface interaction is considered crucial in supporting an effective learning process, especially for students who are still adapting to new technologies (Zaim et al., 2023). The highest-scoring visual appeal, which was 90, indicates that visual elements such as color, characters, and animation in this media have succeeded in attracting students' attention. High visual appeal in AR-based learning media can increase students' interest in learning because this media provides a more enjoyable learning experience. (Molina et al., 2023).

However, the accessibility aspect of AR features rated 82 indicates that there are few challenges that may be related to the responsiveness or how to use AR features. It is a relevant note that some students experience technical difficulties in using AR-based media. Therefore, improvements to the user guide or simplification of features can be made to maximize the potential of this media. (Mukhtarkyzy et al., 2022).

Media Suitability Based on Practicality by Teachers

On the teacher's side, this media is also considered very feasible with several significant scores in the aspects of suitability with teaching methods (92), effectiveness in achieving learning objectives (88), and influence on student learning motivation (90). High scores on the suitability of media with teaching methods indicate that this media can be easily integrated into existing curricula or lesson plans, without requiring major changes in teaching strategies. Learning media that are in accordance with teaching methods can support smooth learning and help teachers achieve learning objectives more effectively (Devega et al., 2022).

The effectiveness of the media in achieving learning objectives assessed at 88 confirms that this media is not only interesting, but also successful in improving students' understanding of the material. AR-based media can improve students' understanding of learning materials, especially concepts that require in-depth visualization. In this case, the use of AR in health comics is very relevant to help students understand the concept of washing hands and disposing of waste properly. (Devega et al., 2023)

The high score on student learning motivation (90) shows that this media has succeeded in encouraging students to be more interested and active in learning. Technology-based learning media, especially AR, has a positive effect on student learning motivation because of its interactive and interesting nature. (Molina et al., 2023) This is also supported by the results of the study which showed that students who interacted with AR media felt more enthusiastic and involved in the learning process.

4. CONCLUSION

The development of interactive learning media based on Augmented Reality (AR) called "GermBusters VR" has proven effective in educating elementary school children about the habit of washing hands and disposing of garbage in its place. Based on the results of the study, this media shows significant value in several aspects of practicality as assessed from the perspective of students, teachers, and validity from material experts and media experts.

Validation by material and media experts showed very positive results, with very satisfying results. Validation by material experts was carried out in two stages. In the final stage, GermBusters VR received a total score of 85 out of 20 items, with an average score of 4.25. This score indicates that the material in the application is in the "very decent" category. Material experts concluded that the health education content in GermBusters VR was very good and did not require revision.

From the results of the practicality assessment by students, this media scored high in readability and understanding of content (88), comfort in using media (85), visual appeal (90), ease of accessibility of AR features (82), and ease of use of technology (87). This score shows that students are not only able to understand the content well, but also feel comfortable and interested when using the media. Meanwhile, the practicality assessment by teachers also showed very good results, with scores on the suitability of the media to the teaching method (92), effectiveness in achieving learning objectives (88), and influence on student learning motivation (90). The aspect of practicality in classroom application scored 85, indicating that this media is easy to use in a teaching context, and student interaction with the media scored 87, indicating that students actively interact with the content presented.

REFERENCES

Agusriani, RT, & Ramadan, ZH (2024). Development of Thematic Teaching Materials Based on Riau Local Wisdom for Elementary School Students. Aulad: Journal on Early Childhood, 7(1), 81–88. https://doi.org/10.31004/aulad.v7i1.590

Anggraena, Y., Felicia, N., Ginanto, DE, Pratiwi, I., Utama, B., Alhapip, L., & Widiaswati, D. (2022). Academic Study of Curriculum for Learning Recovery (1st ed.). Center for Curriculum and Learning, Agency for Standards, Curriculum, and Educational Assessment, Ministry of Education, Culture, Research, and Technology.

Buchner, J., & Zumbach, J. (2018). Promoting Intrinsic Motivation with a Mobile Augmented Reality Learning Environment. International Association for Development of the Information Society. https://eric.ed.gov/?id=ED590357

De Vries, J., Dimosthenous, A., Schildkamp, K., & Visscher, A. (2022). The impact on student achievement of an assessment for learning teacher professional development programs. Studies in Educational Evaluation, 74. https://doi.org/https:/doi.org/10.1016/.stueduc.2022.101184

De-Graft, J., & Asante, F. (2022). The role of academic libraries in the achievement of quality education as a sustainable development goal. Library Management, 45(6), 439–459. https://doi.org/https://doi.org/10.1108/LM-02-2022-0013

Devega, AT, Ambiyar, A., Panyahuti, P., Adi, NH, & Riyanda, AR (2023). Design development and evaluation of a virtual reality game-based application to support computational thinking. Education Tech Research Dev, 71, 507–537. https://doi.org/https://doi.org/10.1007/s11423-022-10161-5

Devega, AT, Ambiyar, A., Panyahuti, P., Adi, NH, & Riyanda, AR (2022). The Effectiveness of Learning Media on the Outcome of Computer and Basic Network of Vocational Students. Journal of Vocational Technology Education, 5(2), 47–52. https://doi.org/10.24036/jptk.v5i2.23123

Dewi, RW, Sutarba, MU, Unidah, U., Rahmi, SU, & Hadiansyah, Y. (2022). Utilization of Interactive Video Media in Further Developing Student Learning Outcomes on Natural Pollution Material in Junior High Schools.Educatio. https://doi.org/10.29408/edc.v17i1.5725

Drljača, D., Latinović, B., Stanković, Ž. & Cvetković, D. (2017). ADDIE Model for Development of E-Courses. International Scientific Conference on Information Technology and Data Related Research. https://doi.org/10.15308/SINTEZA-2017-242-247

Ferrari, M., Allan, S., Arnold, C., Eleftheriadis, D., Alvarez-Jimenez, M., Gumley, A., & Gleeson, J. (2022). Digital Interventions for Psychological Well-being in University Students Systematic Review and Meta-analysis. Journal Of Medical Internet Research, 24(9), 1–17. https://doi.org/http://dx.doi.org/10.2196/39686

Fonseca, D., & García-Peñalvo, F. J. (2019). Interactive and collaborative technological ecosystems for

improving academic motivation and engagement. Universal Access in The Information Society. https://doi.org/10.1007/S10209-019-00669-8

Goldschmidt, S., Schmidt, M., Rosenberger, F., Wiskemann, J., & Steindorf, K. (2024). Patterns and influencing factors of exercise attendance of breast cancer patients during neoadjuvant chemotherapy. Supportive Care in Cancer, 32–79. https://doi.org/https://doi.org/10.1007/s00520-023-08269-2

Gustilo, L., Ong, E., & Lapinid, M. (2024). Algorithmically-driven writing and academic integrity exploring educators practices perceptions and policies in the AI era. International Journal for Educational Integrity, 20(3), 1–43. https://doi.org/https://doi.org/10.1007/s40979-024-00153-8

Irwansyah, FS, Ramdani, I., & Farida, I. (2017). The development of an Augmented Reality (AR) technology-based learning media in metal structure concept. Taylor and Francis. https://www.taylorfrancis.com/chapters/edit/10.1201/9781315166575-47 Zaim, RA, Annisa, S., Purnomo, EE, Widarsa, AH, & Kharisma, M. (2023). Interactive learning media using augmented reality. JSR*: Robotic Information System Network*. https://doi.org/10.58486/jsr.v7i1.223

Ispas, C., Vişan, A.D., Constantin, A.C., & Lungu, G. (2022). The Management of Discipline Problems in the Classroom. European Proceedings of Educational Sciences. https://doi.org/10.15405/epes.22032.31

Kabra, U. (2022). Integrity as the Goal of Character Education. Royal Institute of Philosophy Supplement. https://doi.org/10.1017/s1358246122000273

Kairgozhin, D., Kuzembayeva, G., Maydangalie, Z., Bakhtiyarova, S., & Mugauina, G. (2023). Pedagogical conditions for the development of cognitive independence in physical education lessons. Journal of Education and E-Learning Research, 10(3), 539–547. https://doi.org/10.20448/jeelr.v10i3.4952

Karo-Karo, IR, & Rohani, R. (2018). Benefits of media in learning. AXIOM*: Journal of Education and Mathematics*, 7(1). https://doi.org/10.30821/AXIOM.V7I1.1778

Madani, E., Sulistyani, A., & Utami, DN (2022). Factors and Handling of Reading Difficulties of Grade III Students of Daarul Hikmah Elementary School, Tangerang. Greetings. https://doi.org/10.15408/sjsbs.v7i11.28253

Molina, R., Abde, F., Ce, W., BC, G., & Hartanto, A. (2023). A game model in physical education to improve motor skills cooperation and discipline of primary school learners.Sportpedagogy, 27(6). https://doi.org/https://doi.org/10.15561/26649837.2023.0602

Muassomah, M., Abdullah, I., Hasanah, U., Dalmeri, D., Sihombing, AA, & Rodrigo, LM (2022). The Academic Demoralization of Students in Online Learning during the COVID-19 Pandemic. Frontiers in Education. https://doi.org/10.3389/feduc.2022.888393

Muhtar, T., Dalyono, R., & Kata, K. (2020). Character Education from the Perspectives of Elementary School Physical Education Teachers. Educational Horizons, 39(2), 395–405. https://doi.org/doi:10.21831/cp.v39i2.30647

Mukhtarkyzy, K., Abildinova, G., & Sayakov, O. (2022). The Use of Augmented Reality for Teaching Kazakhstani Students Physics Lessons. International Journal of Emerging Technologies in Learning (Ijet). https://doi.org/10.3991/ijet.v17i12.29501

Purwatmiasih, F., & Oktavia, R. (2021). Academic Fraud in Online Systems during the COVID-19 Pandemic: Evidence from Lampung - Indonesia. Asian Journal of Economics, Business and Accounting, 34(2), 34–52. https://doi.org/10.9734/AJEBA/2021/V21I230349

Rahmawati, R., Wangid, M., & Purnomo, Y. (2024). Designing Model of Mathematics Instruction Based on Computational Thinking and Mathematical Thinking for Elementary School Students. Mathematics Teaching Research Journal Early Spring, 16(1). https://mtrj.commons.gc.cuny.edu/

Salam, R., Akib, H., & Daraba, D. (2018). Utilization of Learning Media in Motivating Student Learning. Proceedings of the 1st International Conference on Social Sciences (ICSS 2018). https://doi.org/10.2991/ICSS-18.2018.232

Susila, HR, Muslim, S., & Syahrial, Z. (2019, April 14). Interactive Multimedia to Enhance Students'

Engagement.The Internet of Things. https://doi.org/10.4108/EAI.19-10-2018.2281286

Taneri, A., & Mutlu, D. K. (2022). Investigation of Primary School Children's Views of Life during the COVID-19 Pandemic through Metaphors. European Journal of Educational Sciences. https://doi.org/10.19044/ejes.v9no1a11

Tsakeni, M. (2021). Preservice Teachers Use of Computational Thinking to Facilitate Inquiry-based Practical Work in Multiple-deprived Classrooms. EURASIA Journal of Mathematics, Science and Technology Education, 17(1). https://doi.org/https://doi.org/10.29333/ejmste/9574

Tsekhmister, Y., Konovalova, T., Tsekhmister, B., Pushkarova, T., & Nahorniak, S. (2024). Contemporary education globalization and transformation process under the influence of artificial intelligence. International Journal of Evaluation and Research in Education (IJERE), 13(5), 3443~3455. https://doi.org/10.11591/ijere.v13i5.29016

Zosh, J., Pyle, A., D'sa, N., Omoeva, C., Robson, S., Ariapa, M., Giacomazzi, M., Escallón, E., Maldonado-Carreño, C., & Ferdous, K. (2024). Applying the science of learning to teacher professional development and back again Lessons from 3 country contexts. Trends in Neuroscience and Education, 36. https://doi.org/https://doi.org/10.1016/j.tine.2024.100225