



Development of Electronic Worksheet Assisted by Augmented Reality to Improve Learning Outcomes and Interest in Learning Science

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Abstract

This research aims to: 1) produce feasible and valid electronic worksheets assisted by augmented reality that can be used to improve learning outcomes and interest in learning science; and 2) know the effectiveness of electronic worksheets assisted by augmented reality to improve learning outcomes and interest in learning science. This study used 4D model R&D research. The research was conducted in SMP Madiun City with class VIII research subjects totaling 17 students. Data collection instruments include product validation and feasibility tests, pretest and posttest questions, and learning interest questionnaires. Data analysis techniques using paired T-tests. The results obtained from the material validation tests were 63 in the interval $72 \leq X \leq 58.5$ criteria with a very good category, while the results from the media validation tests were 65,25 in the interval $68 \leq X \leq 55,25$ criteria with a very good category. Based on the results of the student response questionnaire, a percentage of 68.35 in the interval $84 \leq X \geq 68.25$ criteria indicates a very good category and is suitable for use. The results of testing learning outcomes and interest in learning science with paired T-tests obtained results of 0.007 and 0.005, indicating that there were differences in learning outcomes and interest in learning science after using electronic worksheets assisted by augmented reality. Thus, it can be said that 1) electronic worksheets assisted by augmented reality have met the eligibility criteria with a very good category according to material experts and media experts, and 2) electronic worksheets assisted by augmented reality are effective in improving learning outcomes and interest in learning science.

Keywords: electronic worksheets; augmented reality; learning outcomes; interest in learning science

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INTRODUCTION

Ki Hajar Dewantara stated that, as a teacher learning is adapted to nature and times. The nature of nature relates to the nature and shape of students, which results in students having different characteristics. Besides that, teachers also need to pay attention to the nature of the times, as currently in the technological era, it is expected that teachers equip students with technology-based 21st century skills (Carolina, 2023; Purwandari et al., 2021). So that we can face the 21st century, UNESCO, through the journal "The International Commission on Education for the Twenty First Century," recommends continuing education that is carried out based on the four pillars of the learning process, namely: learning to know, learning to do, learning to be, and learning to live together. So that the teacher, as a learning agent is able to realize this, it requires mastering and applying information and communication technology in learning (Jamun, 2018).

Teachers are currently dealing with digital native students, who are the generation that was born and grew up with the rapid development of technology. So that teachers in the

learning process can take advantage of technology because the characteristics of digital native students are everything related to technology, innovation, and collaboration (Carolina, 2023). Junior high school students generally have just entered the stage of cognitive development from concrete operations to formal operations, which results in students experiencing learning difficulties, especially in science (Nurhidayanti et al., 2022; Yusro, Safitri, et al., 2023). The difficulties experienced by students in learning science were dominated by abstract material because the learning objects being studied were not found around them. This causes low learning outcomes and low learning interest because students have difficulty understanding abstract material (Rondoni et al., 2022).

Other factors that cause low science learning outcomes include students not being actively involved in learning and the lack of varied and innovative learning used (Dewi et al., 2020; Handayani, 2020; Prastiti et al., 2023; Sambudi et al., 2023). Meanwhile, according to Meilani and Aiman (2020), factors that affect the low science learning outcomes include conventional learning, limited learning resources, learning that only focuses on cognitive skills because learning is teacher-centered, and students who are not accustomed to using their abilities according to the times. Meanwhile, other factors that cause low interest in learning science are teaching materials that do not support abstract material, so that students have difficulty understanding the material and assume that most science materials are difficult to understand (Rondoni et al., 2022).

This difficulty can be overcome by utilizing IT-based media. This is because technology can provide access to abstract and obscure phenomena for novice learners (Boholano, 2017). One medium that can concretize abstract concepts so that an object can be understood easily and can be displayed in real terms is augmented reality (AR) (Purwandari et al., 2021; Jumbri & Ishak, 2022). Winda et al. (2023) states that AR can help teachers help students understand abstract and contextual material. AR is a technology that can combine the real world and the virtual world in real-time, so it seems that there are no boundaries between the two (Permana et al., 2019). Where AR can combine the real world and the virtual world, there are a series of 3D and 2D images designed in the form of cards and software that can be run via a computer or smartphone so that they can explain abstract material or events that cannot be observed directly (Elisa & Wiratmaja, 2019). AR media will be more effective when combined with other technologies, such as electronic learning media using smartphones (Permana et al., 2019). So that to improve learning outcomes and interest in learning science, interactive and varied teaching materials are also needed. One of the teaching materials that is widely used by teachers is LKPD. This is because LKPD is a teaching material that can fully develop students' abilities in the learning process (Winda et al., 2023). However, some teachers do not use LKPD and are only guided by the material listed in the book (Hariyanti, 2022).

However, augmented reality-based learning has not been implemented optimally because there is still little socialization, training, and support related to augmented reality (Lai et al., 2019; Rongting et al., 2016). The utilization of information technology in the world of education by teachers is still not optimal. This situation is due to inadequate facilities and teacher skills in understanding and using information technology-based learning media, which are still lacking (Abdullah, 2017). There are still teachers who are limited in using technology in face-to-face or online learning. This means they cannot further access related information on the internet network, use various learning applications, create their own learning media, and so on (Asmuni, 2020).

Based on the background described above, researchers are interested in developing electronic worksheets assisted by augmented reality to improve learning outcomes and interest in learning science class VIII about the human excretory system. This study has the following objectives: 1) to produce electronic worksheets assisted by augmented reality that are feasible and valid to use to improve learning outcomes and interest in learning science,

and 2) to determine the effectiveness of electronic worksheets assisted by augmented reality to improve learning outcomes and interest in learning science.

METHOD

This research is development research that aims to produce electronic worksheet products assisted by augmented reality. The development model used is a 4D model with define, design, develop, and dissemination stages (Rusdi, 2018), but due to time constraints, the model is simplified back to 3D (define, design, and develop). This study's research subjects were junior high school students from the Madiun academic year 2022/2023.

The sample in this study used a simple random sampling technique, namely 17 students in Class VIII-E for a limited test. The research was conducted in even semesters during February–March 2023. The limited trial design used the one-group pretest-posttest design model. The research instruments included assessing the feasibility of electronic worksheets assisted by augmented reality and creating questions and questionnaires to gauge interest in learning science. The technique of feasibility analysis and validation of electronic worksheets assisted by augmented reality involves calculating the average of each aspect of the assessment, then converting quantitative scores into qualitative data on a scale of four with the formula $\bar{X}_i = \frac{\sum x}{n}$ where \bar{X} : average score, $\sum x$: total score, and n : number of assessments, then converting the data to Table 1.

Table 1. Scale Assessment Criteria 4

Mark	Score Range	Criteria
4	$(\bar{X}_i + 3S_{bi}) \geq \bar{X} \leq (\bar{X}_i + 1,5S_{bi})$	Very good
3	$(\bar{X}_i + 1,5S_{bi}) > \bar{X} \geq \bar{X}_i$	Good
2	$(\bar{X}_i > \bar{X} \geq (\bar{X}_i - 1,5S_{bi}))$	Not good
1	$(\bar{X}_i - 1,5S_{bi}) > \bar{X} > (\bar{X}_i - 3S_{bi})$	Very Not Good

(Lukman & Ishartiwi, 2014)

Then analyze the effectiveness of the electronic worksheets assisted by augmented reality in improving learning outcomes and interest in learning science with paired sample t-tests for each variable. The purpose of using the t-test statistical calculation is to find out whether there is a significant difference between the data resulting from the students' pretest and posttest scores. In this study, the results of students' pretest and posttest scores were analyzed using the normality test first as a prerequisite using the paired sample t-test. For the criteria for making a decision based on the paired sample t-test, that is, if the significance value is <0.05 , then there is a difference in the samples that have been tested. Then, if the significance value is > 0.05 , there is no difference in the samples tested (Rosana & Setyawarno, 2016).

RESULTS AND DISCUSSION

The research results and discussion can be divided into two parts according to the number of research objectives. In detail, it can be presented as follows:

Generate electronic worksheets with the help of Augmented reality.

The product produced in this study is an electronic worksheet assisted by augmented reality to improve learning outcomes and interest in learning science class VIII on the material excretory system in humans. This research uses 3D (define, design, and develop). At the define stage, the authors carry out planning related to needs analysis and curriculum. At the design stage, the author does four steps, including: 1) selection of teaching media, namely electronic worksheets assisted by augmented reality, 2) design of electronic worksheets assisted by augmented reality, and 3). Selection of AR-assisted electronic worksheet format 4) Materials for augmented reality are to be made.



Figure 1. Design of electronic worksheets assisted by augmented reality.

At the develop stage, the author makes teaching materials that have been designed. At this stage, there were validation activities conducted by media and material expert validators, including junior high school science teachers and six people who were experts in science learning. The results of the material test with 4 Liker scales can be found in Table 2.

Table 2. Media Expert Validation Test Results

No	Indicator	Score (X)	intervals	Criteria
1	Compliance with the general provisions of worksheets	37,66	$40 \leq X \geq 32.5$	Very good
2	Operation of Electronic worksheets	27.58	$28 \leq X \geq 22.75$	Very good
Average		65,25	$68 \leq X \geq 55,25$	Very good

Based on Table 2, the indicator of conformity with the general provisions of the worksheets gets a value of 37.66 in the interval $40 \leq X \geq 32.5$ in the very good category, and the operational indicator of the electronic worksheets gets a value of 27.58 in the interval $28 \leq X \geq 22.75$ with very good category. In general, the average value of the media aspect is 62.25 in the interval $68 \leq X \geq 55.25$ in the very good category.

Furthermore, an analysis of the validity of electronic worksheets assisted by augmented reality material aspects was carried out. The results of the analysis can be found in Table 3.

Table 3. Material Expert Validation Test Results

No	Indicator	Score (X)	intervals	Criteria
1	Learning Design	26	$28 \leq X \geq 22.75$	Very good
2	Content Material	26	$28 \leq X \geq 22.75$	Very good
3	Language and communication	11	$12 \leq X \geq 9.75$	Very good
Average		63	$72 \leq X \geq 58.5$	Very good

Table 3 shows that the value for the learning design indicator is 26 in the interval $28 \leq X \geq 22.75$ in the very good category, the material content indicator is 26 in the interval $28 \leq X \geq 22.75$ in the very good category, and the language and communication indicator is 11 in the interval $12 \leq X \geq 9.75$ with very good category. Thus, the average material validity value of 63 is in the interval $72 \leq X \geq 58.5$ with a very good category.

These results indicate that the electronic worksheets assisted by augmented reality are ideal in accordance with the criteria or measure that is to be measured both in terms of media and learning materials. In terms of the media, it obtained a score of 65.25 with very good criteria. In the aspect of general provisions, the criteria assessed include inclusion of titles, objectives, student identity, augmented reality, worksheet design, and language, all of which

get very good ratings. This is because the worksheets developed are in accordance with the worksheet structure in general (Hariyanti, 2022) in the form of titles, identities, objectives, tools and materials, procedures, data tables, and materials for discussion. In this aspect, there is input from the validator, including improving the appearance to make it look more attractive and clarifying problem-based learning syntax in worksheets. The worksheets that the researcher developed are equipped with augmented reality, which is used to make it easier for students to understand abstract material in the form of structures in the organs of the human excretory system and create a pleasant learning atmosphere so that they can practice certain skills to meet learning objectives (Elisa & Wiratmaja, 2019). With the help of AR, students can improve content understanding, improve long-term memory retention, improve physical task performance, increase collaboration, and increase motivation to learn (Permana et al., 2019). In the operational aspect of the electronic worksheets, it got a very good category. This is because the electronic worksheets developed use liveworksheets so that students can easily operate them and work on them without having to download them or register an account. The AR added in the worksheets is easy to operate because the AR link is included in the worksheets, so students only need to click on the provided link. AR can be opened with the Assemblr Edu application or Google, so it is easy to operate because students cannot download the Assemblr Edu application and can use Google.

In terms of material overall, it obtained a score of 63 with very good criteria. In the learning design aspect, it is in a very good category because the material is in accordance with learning objectives, the material is in accordance with basic competencies, the material is in accordance with learning indicators, and AR can make it easier for students to learn the structure of human excretory organs and coherent material. The worksheets developed by the researcher use the PBL syntax so that it can activate students in learning and will make it easier for students to understand because they are faced with contextual problems that are in the environment. In the content aspect, the material is in a very good category because the material is packaged attractively with the help of augmented reality so that it attracts the attention of students and can facilitate the material for the parts of the excretory organs that are abstract in nature (Carolina, 2023). In the aspect of language and communication, the criteria are very good because the language in the worksheets is adjusted to the level of development of the students and augmented reality is used to explain the parts of the excretory organs that are abstract in nature (Carolina, 2023).

Readability Test

After the product has been revised, the next step is to conduct a readability test with field practitioners, junior high school science teachers, and students. The results can be seen in Tables 4 and 5:

Table 4. Limitations Test Results by Science Teacher field practitioners

No	Indicator	Score (X)	intervals	Criteria
1	Interest	20	$20 \leq X \geq 16,25$	Very good
2	Material	11	$12 \leq X \geq 9.75$	Very good
3	Language	10	$12 \leq X \geq 9.75$	Very good
4	Appearance	19	$20 \leq X \geq 16,25$	Very good
5	User	20	$20 \leq X \geq 16,25$	Very good
Average		80	$84 \leq X \geq 68.25$	Very good

Table 5. Limitations Test Results by students

No	Indicator	Score (X)	intervals	Criteria
1	Interest	16,29	$20 \leq X \geq 16,25$	Very good
2	Material	9.94	$12 \leq X \geq 9.75$	Very good
3	Language	9.35	$9.75 < X \geq 7.5$	Good

No	Indicator	Score (X)	intervals	Criteria
4	Appearance	16.35	$20 \leq X \geq 16,25$	Very good
5	User	16,41	$20 \leq X \geq 16,25$	Very good
Average		68.35	$84 \leq X \geq 68.25$	Very good

Based on the readability test by field practitioners, a score of 80 was obtained in the very good category. Meanwhile, the students obtained a score of 68.35 in the very good category. It can be concluded that field practitioners and students get very good categories for both. This shows that theoretically, electronic worksheets assisted by augmented reality are feasible to use in the science learning process.

The effectiveness of electronic worksheets assisted by augmented reality to improve learning outcomes and interest in learning science.

Teaching material products that have been revised based on input from the validator underwent limited trials during science lessons in class VIII. Before the test was carried out, the researcher conducted a research instrument validation test in the form of questions and a learning interest questionnaire modified from the research of Arista Rahmayanti (2016). Sola has been validated by experts. Questionnaire interest in learning science, researchers conducted empirical tests, namely testing the validity and reliability of science in class VIII. After all the instruments were valid, the researchers conducted research on the effectiveness of electronic worksheets assisted by augmented reality to improve learning outcomes and interest in learning science.

Learning outcomes

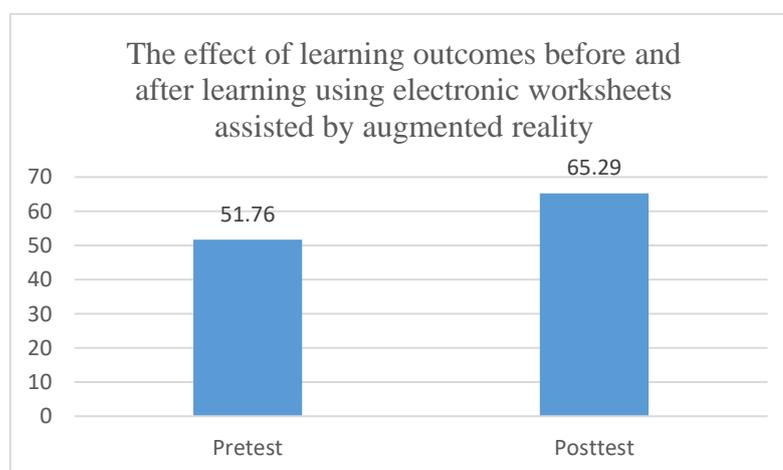


Figure 2. Average Pertest and Post-test Study Results

Based on the results of the pretest before using the developed teaching materials, it obtained a value of 51.76. After using the teaching materials developed, the students obtained a score of 65.29. There is an increase in learning outcomes after using the developed teaching materials of 26.14%. This shows that after using the electronic worksheet assisted by augmented reality, there are differences in the results of the pretest and posttest. Furthermore, the researchers conducted a paired T-test to see the effect of learning outcomes after using augmented reality-assisted electronic worksheets. Previously, the normality test was carried out as a prerequisite test, and normal results were obtained for both with pretest results of 0.200 and 0.078 on the posttest. Based on the normality test, the data used is normally distributed.

Table 6. Paired T-Test Results for Learning Outcomes

Group	Average	Sig	Criteria
Pretest	51,76	0.007	Significantly different
Posttest	65,29		

Based on table 6, the sig. (2-tailed) 0.007, namely <0.05 , so that it can be said that there is a significant difference in the pretest and posttest values. sig. value The results obtained also show that there is an effect of using electronic worksheets assisted by augmented reality on class VIII human excretory system material. These results are in line with the opinion of Rizki et al. (2018), which stated that there was an influence in the use of PBL-based worksheets on excretion system material. With electronic worksheets assisted by augmented reality, it is used to make it easier for students to understand abstract material in the form of structures in the organs of the human excretory system and create a pleasant learning atmosphere so as to improve learning outcomes (Elisa & Wiratmaja, 2019).

Interest to learn.

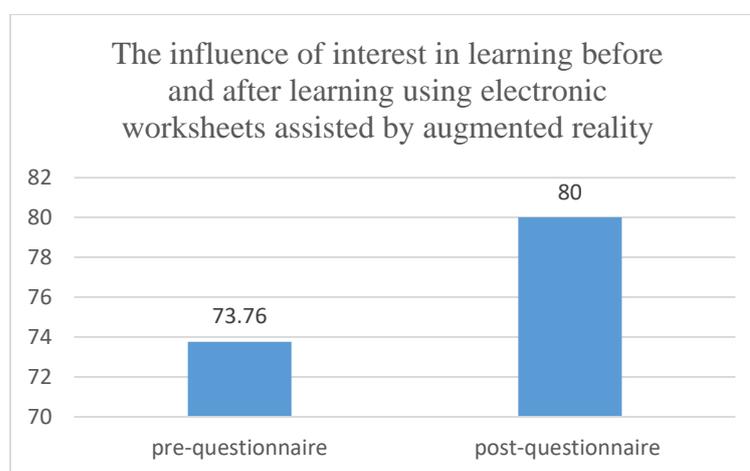


Figure 3. Average Results of Interest in Learning Science Questionnaire Before and After

Based on the results of the pre-questionnaire of interest in learning science before using the developed teaching materials, a value of 73.76 was obtained with the criteria of moderate learning interest (Arikunto, 2013). After using the teaching materials developed, students obtained a score of 80 with the criteria of high learning interest (Arikunto, 2013). It can be seen that there is an increase in interest in learning science after using the teaching materials developed. This shows that after using electronic worksheets assisted by augmented reality, there are differences in the results of interest in learning science. Furthermore, researchers conducted a paired T-test to see the influence of interest in learning science after using electronic worksheets assisted by augmented reality. Previously, a normality test was carried out as a prerequisite test, and normal results were obtained for both with pre-questionnaire results of 0.127 and post-questionnaire results of 0.200. Based on the normality test, it can be seen that the data used is normally distributed. Next, perform a paired T-test with the results in Table 7.

Table 7. Paired T-Test Test Results for Interest in Learning Science

Group	Average	Sig	Criteria
Early Learning Interest	73,76	0.005	Significantly different
Interest in Learning Science After	80		

Based on table 7, the sig. (2-tailed) 0.005, namely <0.05 , so that it can be said that There is a significant difference in the value of the pre-anquette and post-questionnaire. The sig value obtained also showed that there was an effect of using augmented reality-assisted electronic worksheets on interest in learning science. But according to Yusro, Zulfa, et al. (2023) during the covid transition period learning must be packaged as attractively as possible, one of which is by combining the use of ICT (liveworksheet) but not necessarily running as expected. This is because these worksheets are interactive because students are actively involved in learning and technology-based, namely using liveworksheets and augmented reality to become students. digital natives interested in learning so as to increase interest in learning (Carolina, 2023). These results are in line with research. Purwandari et al. (2021) stated that there was an effect of using augmented reality as a learning medium on students' interest in science class.

CONCLUSION

The developed electronic worksheets assisted by augmented reality has met the eligibility criteria in the very good category according to the assessment of media and material experts. Electronic worksheets assisted by augmented reality are effective for increasing learning outcomes and interest in learning science.

RECOMMENDATION

Electronic worksheets assisted by augmented reality can improve learning outcomes and interest in learning science, so it is hoped that the results of this research can become a reference and insight for educators in developing creativity to increase learning that is innovative, interesting, and fun. This research was only conducted in a limited trial due to time constraints, so further research is expected to involve extensive trials.

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