INCREASING STUDENTS' SCIENCE LITERACY THROUGH AUGMENTED REALITY (AR) HUMAN SENSE SYSTEM

Aenurohmah[1], Yuyun Maryuningsih[1], Indah Rizki Anugrah[1]
[1]IAIN Syekh Nurjati, Cirebon, Indonesia
Email: aenurrohmahaen30@gmail.com

Abstract

This study aims to evaluate the increase in students' scientific literacy through the implementation of AR-assisted worksheets assisted by the human sensory system as an effort to increase students' scientific literacy. This research was conducted in March 2023 at Cilimus State High School. The research method used is a Quasi experimental design with nonequivalent design. The population in this study were all students of SMA Negeri Cilimus and the research sample was class XI IPA 4 as an experiment and XI IPA 6 as a control. The instruments used in this study were 10 essay test questions which contained 3 indicators of scientific literacy in competency aspects. The data were analyzed descriptively and inferentially using SPSS software version 29. Based on the data analysis, it was found that there was an increase in students' scientific literacy by implementing the AR-assisted LKPD in the human sensory system. The results of the hypothesis test on increasing students' scientific literacy show a Sig (2-tailed) value of 0.001 <0.05 so Ho is rejected Ha is accepted. The average scientific literacy ability of students using AR-assisted LKPD is higher than the average scientific literacy ability using conventional LKPD. The increase in scientific literacy of superior experimental class students on 3 indicators of scientific literacy with the average acquisition of each indicator is included in the high category.

Keywords: Scientific Literacy, *Compentency,* LKPD, Augmented Reality

Abstrak

Penelitian ini bertujuan untuk mengevalusi peningkatan literasi sains siswa melalui penerapan LKPD berbantuan AR sistem Indra manusia sebagai upaya peningkatan literasi sains siswa. Penelitian ini dilakukan pada bulan Maret 2023 di SMA Negeri Cilimus. Metode penelitian yang digunakan adalah Quasi eksperimental design dengan nonequivalent design. Populasi pada penelitian ini adalah seluruh siswa SMA Negeri Cilimus dan sampel penelitian kelas XI IPA 4 sebagai eskperimen dan XI IPA 6 sebagai kontrol. Instrumen yang digunakan dalam penelitian ini adalah 10 soal tes uraian yang memuat 3 indikator literasi sains Aspek kompetensi. Data di analisis secara statistik deskriptif dan inferensial menggunakan software SPSS versi 29. Berdasarkan analisis data diperoleh terdapat adanya peningkatan literasi sains siswa dengan penerapan LKPD berbantuan AR sistem Indra manusia. Hasil uji hipotesis terhadap peningkatan literasi sains siswa menunjukan nilai Sig (2-tailed) sebesar 0,001 < 0,05 sehingga Ho ditolak Ha diterima. Rata-rata kemampuan literasi sains siswa yang menggunakan LKPD berbantuan AR lebih tinggi dibandingkan rata-rata kemampuan literasi sains yang menggunakan LKPD konvensional. Peningkatan literasi sains siswa kelas eksperimen unggul pada 3 indikator literasi sains dengan perolehan rata rata tiap indikator termasuk dalam kategori tinggi.

Kata kunci: Literasi Sains, Kompetensi, LKPD, *Augmented Reality*

Introduction

Scientific literacy is an essential skill for students to possess. According to the findings of a 2016 study by the World Economic Forum, students require 16 skills to thrive in the 21st century, including the foundation of literacy or fundamental literacy, competence, and character (Ministry of Education and Culture, 2019). Science literacy is one of the sixteen questioned abilities.

Every three years, the Organisation for Economic Co-operation and Development (OECD) uses the Programme for International Student Assessment (PISA) to assess students' scientific literacy. PISA (2018) defines science literacy as a person's ability to use scientific knowledge and scientific process skills to understand and make decisions about the natural environment based on the knowledge they have gained in the process of identifying problems, acquiring new knowledge, explaining scientific phenomena, and drawing conclusions based on evidence related to scientific issues.

According to the PISA 2018 report, science literacy has declined since PISA 2015, when the United States ranked 70th out of 78 countries (OECD, 2019). The results indicate that Indonesia's average level of scientific literacy is lower than the global average. The low level of scientific literacy among Indonesian students is generally attributable to the absence of science-literacy-focused learning activities.

According to Ardianto and Rubbini (2016), inadequate science literacy is caused by multiple factors, including the condition of school infrastructure, human resources, and school administration. In addition, Kurnia (2014) found that the low science literacy of Indonesian pupils is influenced by the curriculum and education system, the applied learning methods and models, and the learning facilities and medium. In fact, students need engaging and interactive media and instructional materials to supplement learning materials. AR (augmented reality) technology can be used as a possible solution.

Augmented Reality (AR) is a technology that, using an Android or a computer, can combine actual environments and virtual objects. AR technology is an evolution of the *Virtual Reality* (VR) concept, which is conceptually distinct. AR adds existing and real reality in the real world with objects that are raised / added (Augmented), where this technology appears to eliminate the 3-dimensional virtual world, merging with the real world (Aripin & Suryaningsih, 2019). In the field of education, augmented reality can be used to introduce intangible objects.

Augmented Reality (AR) is the most recent potential solution for educators to present innovative, informative, and interesting learning and to present 3D virtual objects in real time to convey something abstract, thereby making concepts more tangible (Amdani & Purnamasari, 2022). With static images in textbooks, modules, and worksheets (LKPD), students tend to be less active and learning becomes less interactive because visual media cannot interact with one another. AR-based LKPD (Learn-While-Playing-Device) (Augmented Reality) can be used as a tool to cultivate an interactive learning environment focused on competency skills in science literacy, particularly on the subject of sensory system material.

Typically, the topic of the sensory system is taught solely through photographs and videos; however, through augmented reality (AR) technology, students can interact interactively with the raised sensory instruments, making the learning process more engaging and stimulating student comprehension. Students can determine how to use the application and translate the QR code into a three-dimensional image, identify the components of each sensory device, respond to observation-based questions, and draw conclusions from the learning process. Consequently, the use of AR (Augmented Reality) technology in sensory system learning is essential.

This study seeks to evaluate the impact of *Augmented Reality* (AR)-based student worksheets (LKPD) on the improvement of students' science literacy competency skills when learning about the biology of the human sensory system. With this research, it is anticipated that AR (*Augmented Reality*) technology can be incorporated into the learning process as one of the new interactive media.

Research Method

This study employed a quantitative methodology and experimental research methods. A quasi-experimental design with a non-equivalent control group was used for the experiment. SMA Negeri Cilimus, located at Jl. Panawuan No. 221, Cilimus District, Kuningan Regency, West Java, was the site of the study. The investigation was conducted during the month of March in 2023.

The participants in this investigation were all Cilimus State High School students. This study's sample consisted of eleventh-grade science majors from SMA Negeri Cilimus. This study's sampling method combined probability sampling with plain random sampling. According to Sugiyono (2016), "simplicity is attributed to the random selection of sample members from the population without regard to the stratification of the population." The control classes and experiments are determined by random sampling. This sampling system gives every member of the population an equal chance of being selected. In this study, an experimental class of 36 students from class XI Science 4 and a control class of 36 students from class XI Science 6 comprised the sample of 72 students.

The instrument used in this study was a 10-question description test containing three indicators of scientific literacy competence: (1) scientific explanation of phenomena, (2) evaluation and design of scientific research, and (3) interpretation of scientific data and evidence. The description test questions are used to determine students' science literacy competency abilities as pretest and posttest questions. Three experts have validated and tested the validity and reliability of the queries. Using SPSS software version 29.0, the test results were analyzed, and it was determined that 10 valid and reliable question items with a reliability value of 0.69 were included in the high category.

This study's research procedure consists of three stages: (1) a pretest to determine the initial ability of students before the application of learning with Augmented Reality (AR)-based Student Worksheets (LKPD) human sense systems in experimental classes and learning with torso-assisted Student Worksheets (LKPD) in control classes, (2) the implementation of learning with the application of AR-based LKPD of the human sense system in the experimental class and the control class, and (3) a posttest to evaluate the effectiveness The application was conducted over the course of two meetings pertaining to sensory system material. (3) Posttest, to determine the ultimate ability of students in experimental classes (classes employing AR-based LKPD) and control classes (classes employing conventional LKPD). Collecting and analyzing data on the results of students' scientific literacy competency tests.

The obtained research data were analyzed using descriptive statistics and inferential statistics. The average value of science literacy competence was determined using descriptive statistics, followed by the calculation of N-gain values on the pretest and posttest results of the experimental class (classes using AR-based LKPD) and the control class (classes using conventional LKPD). (Sugiyono, 2016) N-gain is a comparison of the gain score attained by students with the maximum gain score that a student can attain. The N-gain value was calculated to determine if there was an increase in science literacy skills between the experimental class and the control class.

After obtaining the N-gain value, additional inferential statistical analysis, specifically hypothesis testing, was performed to determine the significance of the difference in N-gain values between the experimental class and the control group. Prior to conducting the hypothesis test, normality and homogeneity checks were performed. The purpose of the normality test is to determine whether the distribution of data or variables is normally distributed (Arikunto, 2013). While the homogeneity test is designed to determine whether or not a variation is possessed by the same entity. According to Arikunto (2013), if researchers wish to generalise the results of the study, they must ensure that the sample groups are representative of the same population. After classifying the data as normal and homogeneous, a hypothesis test,

specifically the T-test with an independent t-test, can be conducted. Independent T-test is a test for comparing two unpaired samples. Unpaired samples are identical objects treated differently.

Result and Discussion

Based on the results of students' science literacy competency ability tests that have been carried out in experimental classes (classes using AR-based LKPD) and control classes (classes using conventional LKPD) through 10 description questions, the average *pretest* results are far below the school's minimum completeness criteria (KKM). The results of the *pretest* data analysis of science literacy competency ability can be seen in Table 1.

Table 1. Results of *Pretest* Analysis of Science Literacy Competency Ability

Class	Score		Average Rating	Number of Students	Category
	Min	Max			
Experiment	13	46	25,5	36	Low
Control	10	56	26,58	36	Low

The results of *pretest* data analysis in the experimental class obtained the highest score of 46 and the lowest value of 13 with an average value of 25.5. While the *pretest* result data in the control class obtained the highest score of 56 and the lowest value of 10 with an average value of 26.58.

Table 2. *Posttest* Analysis Results of Science Literacy Competency Ability

Class	Score		Average Rating	Number of Students	Category
	Min	Max			
Experiment	51	90	67,33	36	Low
Control	23	75	55,39	36	Low

In the experimental and control groups, the average posttest score for students' science literacy competency has increased compared to the pre-test, as determined by posttest data analysis. The experimental class's posttest data analysis yielded the highest score of 90, the lowest score of 51, and an average score of 67.33. While the results of the posttest for the control group ranged from a high of 75 to a low of 23, with an average of 55.39.

On the pretest and posttest results of the experimental class and control class, N-gain calculations were performed to obtain a neutral gain value; this was done to eliminate the assumption that the class with the highest gain value exhibited the greatest learning results. Table 6 displays the results of calculating the N-gain value.

Table 3. Experimental and control class N-gain results

Class	N-Gain	Description
Experiment	0,6	Medium
Control	0,4	Medium

Calculating the N-gain value from the pre- and post-test results of the experimental class and the control class yielded experimental class N-gain scores of 0.6 and 0.4.

Additional evaluations of normality and homogeneity were performed on the experimental and control classes' N-gain calculations. A normality test is conducted to determine whether the acquired data has a normal distribution or is from a normal population. Table 4 displays the results of the Kolmogorov-Smirnov normality test analysis.

Table 4. Normality Test Results of N-Gain Values of Experimental and Control Classes

	Group	df	Sig
Score	Experiment	36	0.200
	Control	36	0.200

In Table 5, the results of the *Kolmogorov-Smirnov* normality test using IBM *SPSS* Statistic version 29.0 the *N-gain* value of the experimental and control classes is the same result of 0.200. Data is normally distributed if sig. greater than 0.05. Based on the results of the normality test obtained, it can be concluded that the distribution of experimental and control class data is normally distributed.

Table 5. Test Results of Homogeneity of N-Gain Value of Experimental and Control Classes

	df	Sig
Levene's Test for Equality of variances	70	0.369

The homogeneity test was conducted using Levene's Test and version 29.0 of IBM SPSS statistics. If sig. or probability is greater than 0.05, data is homogeneously distributed. According to the results of the homogeneity test presented in Table 8, the calculated N-gain values of the experimental and control classes are distributed homogeneously with the sig value. The quantity was 0.369%. After confirming that the data are normal and homogeneous, a hypothesis test can be conducted.

The purpose of the hypothesis test was to determine whether there was a statistically significant difference between the experimental class and the control class in terms of the increase in science literacy. The T-test, which is an independent T-test, is utilized to test the null hypothesis. Table 9 demonstrates the outcomes of the hypothesis test.

Table 6. Results of Independent Hypothesis Test t-test Experimental and Control Class

	t-test for Equality of Men's					
	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Equal variances assumed	70	0.001	0.15028	0.03609	0.07831	0.22225
Equal variances not assumed	66,3	0.001	0.15028	0.03609	0.07824	0.22232

Based on Table 9 of the results of the independent homogeneity test using IBM SPSS Statistic version 29.0 and a known Sig. (2-tailed) value of 0.0010.05, it can be concluded that H0 is rejected and Ha is accepted based on the independent t-test.

Written exams administered at the start of instruction in the experimental class and the control class reveal that the control class achieves higher scores than the experimental class. This is demonstrated in Table 4, which demonstrates that the experimental class received a mean score of 25.5 while the control class received a mean score of 26.58. Based on these data,

the class is treated differently. In the experimental class, Augmented Reality-based LKPD was used to facilitate learning, while the control class utilized conventional LKPD.

This AR-based Student Worksheet (LKPD) is novel for students. This is supported by Abdullah's (2018) findings that pupils are unfamiliar with augmented reality technology as a learning medium. For AR-based LKPD learning, pupils with this sensory system need smartphones. Students will detect available markers in LKPD using the Assembler Edu application that has been previously installed on their Android smartphones; the application will automatically activate the camera. Once the application has identified and marked the marker pattern, the camera will display 3D animations or videos based on its database.

After each class received a distinct treatment, the experimental class obtained a higher average on the posttest than the control class. The average posttest score of the experimental group is 67.33, while the average score of the control group is 55.39, as shown in Table 5. Therefore, the N-gain value was calculated using the pre- and post-test scores of experimental and control classes to ascertain the increase in students' science literacy competence.

In Table 6 above, the results of calculating the N-gain value of the experimental class and the control class indicate a 0.6 increase in the experimental class. While the control group increased by only 0.4%. A follow-up test, a hypothesis test, was conducted to determine whether there was a significant difference between experimental and control class students in their capacity to improve their science literacy. Table 9's hypothesis test results indicate Sig (2-tailed) values of 0.001 0.05, so H0 is rejected and H1 is accepted, indicating that there is a significant difference in increase between the experimental and control groups. This is consistent with research conducted by Lestari et al. (2018), which indicates that augmented reality (AR) learning media helps students comprehend the material they are learning, thereby improving learning outcomes. This suggests that AR-based LKPD can enhance students' scientific literacy.

Mustaqim (2016) stated that the use of learning media with augmented reality (AR) technology is very useful for enhancing the learning process and student interest in learning because AR itself has entertainment aspects that can increase student interest in learning and playing, project it in the real world, and involve the interaction of all five senses with this AR technology. This is because AR has nearly identical characteristics and functions to learning media, which functions to convey information between recipients and senders or students and teachers, can clarify the delivery of information provided by educators and students during the learning process, and can provide motivational stimulation and interest in learning.

Conclusion

Based on the results of the research, it can be concluded that students at Cilimus State High School improved their science literacy through the use of the AR-based LKPD sensory system, as evidenced by the results of the analysis of the calculation of the N-gain value, which yielded a value of 0.6 with no statistical significance. Therefore, AR-based LKPD can be used as an interactive learning medium that can be applied to the learning process, according to researchers.

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