Effectiveness of Augmented Reality with Cognitive Conflict Model to Improve Scientific Literacy of Static Fluid Material

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***Abstract*—Augmented reality is becoming a commonly used technology today to present real-world phenomena such as conditions. The reliability of this technology is suitable for training scientific literacy because scientific literacy is related to the ability to explain, interpret, and investigate phenomena scientifically. This study aims to determine the effectiveness of augmented reality with cognitive conflict models to improve scientific literacy of static fluid materials. The study used a quasi-experimental design involving 36 students in the control group and 36 students in the experimental group. Static fluid material literacy test instruments are used to measure students' abilities. The results of research through the Mann-Whitney test showed a significance value Sig (2-tailed) <0.05, which informed that there is a significant effect of learning by utilizing augmented reality with cognitive conflict model compared to conventional learning.**

***Keywords*—augmented reality, static fluid, scientific literacy, cognitive conflict model**

I. Introduction

21st-century learning focuses on mastering skills, and one of the crucial aspects is scientific literacy. These skills include the ability to recognize and understand real-world phenomena that occur on a day-to-day basis. Mastery of scientific literacy has an important role in helping individuals solve real-world problems in a more structured, organized, and understandable manner [1]. Scientific literacy is not only an essential need in 21st-century education but also the key to producing individuals who are able to think critically, solve problems, and make a positive contribution to society.

In education, scientific literacy is the standard of ability that students need to have in explaining and interpreting scientific data. The presentation of material in scientific literacy emphasizes context, content, and competence [2]. The context deals with the presentation of real-world phenomena. Content is related to learning materials, especially in physics. Meanwhile, competence relates to the ability to explain, investigate, and interpret data. In addition, the phenomena presented in scientific literacy are also related to global, environmental, health, and technological issues [3–5].

Physics is the part of science that discusses natural phenomena. One of the physical phenomena associated with fluids is related to liquids and gases [6]. Learning physics is closely related to the ability to investigate and interpret natural phenomena related to everyday life [7]. A good understanding of physics reflects a good mastery of students' scientific literacy. Therefore, these conditions allow students to have an ideal ability to uncover scientific facts and solve real-world problems related to the phenomena of everyday life.

Real conditions that occur in Indonesia show that students' mastery of scientific literacy is still in the low category. Based on the PISA 2022 test results, the information shows that Indonesia literacy test scores are below OECD standards in the low category [1]. The results of preliminary research inform the mastery of scientific literacy students in high school fluid material is in the low category [8]. This condition is caused by the lack of emphasis on learning that supports scientific literacy and the interactivity of presenting phenomena in learning. Students have difficulty in explaining and interpreting data related to fluid phenomena in everyday life. Visualization of phenomena such as real conditions in learning is one way to explain scientific phenomena, which is part of the scientific literacy indicator. The presentation of material in previous learning on static fluid material was limited to images and videos. This problem provides an opening for further investigation to test effective techniques used to improve scientific literacy by utilizing three-dimensional technology.

Augmented Reality (AR) is one of the best three-dimensional technologies today for visualizing phenomena. Augmented reality and virtual reality technology are becoming popular modern technologies in learning to bring virtual objects into the real environment or vice versa [9–11]. Augmented reality is able to visualize and simulate physics problems in 3D form through smartphone technology [12, 13]. This technology is ideal for use in supporting the presentation of fluid phenomena in supporting students' scientific literacy. In addition, the ability of scientific literacy is closely related to the ability to explain, interpret, and investigate, so the application of models oriented to concept discovery and investigation is the right solution to support the implementation of scientific literacy. The application of learning models that are oriented to real-world contexts, discovery and inquiry is the best choice in supporting the acquisition of 21st-century skills [14–16].

AR research studies in the field of science have been developed by many previous researchers. Results from 16 AR research studies revealed the positive effects of using AR as a supporting medium for science learning [17]. A grouping of 39 studies reported that AR is used to encourage increased academic achievement, which is presented in the form of printed book variations, as an experimental medium, integration with inquiry learning models, and simulation media [18]. AR is presented in the form of simulations and laboratories in science learning which are presented specifically and separately in learning [19–21]. AR is applied by combining it with inquiry learning models [22]. Overall,

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reports of previous studies on AR have not linked it to cognitive conflict learning models as a whole in an application. AR learning interventions by integrating them alongside cognitive conflict models supporting scientific literacy have yet to be implemented. The integration of AR with cognitive conflict models aims to support the improvement of students' scientific literacy. The research innovation informs the novelty of this study compared to previous researchers.

The cognitive conflict model is a form of learning model that is oriented towards investigation and discovery of concepts and equations. This model has advantages in concept improvement and misconception remediation [23]. In addition, the implementation of this model emphasizes the presentation of the phenomenon being solved and formulating the problem in a scientific step that thinks deeply [24]. Each stage in this model plays a role in supporting mastery of concepts and solving problems related to phenomena in everyday life.

One of the stages of this model is the presentation of cognitive conflicts and the discovery of concepts and equations. This stage requires visualization of phenomena that cause conflict in students' thinking and helps the investigation process in experimental activities that are characteristic of this model. This condition is in line with the advantages of AR which is able to represent phenomena and support the investigation process as the original in visualizing three-dimensional forms in the real environment. In addition, the cognitive conflict model is aligned with the characteristics of scientific literacy related to problem-solving based on context and content in everyday life. The process of visualization of phenomena, investigations that support the mastery of scientific literacy has a relationship that matches the characteristics of cognitive conflict models and AR.

The implications of this model with augmented reality technology to be applied in learning are ideal. Based on the disagreement between the conditions that occur and the advantages of augmented reality technology and cognitive conflict models, further investigation in an effort to see the effects of learning in improving scientific literacy needs to be carried out. Thus, this study aims to determine the effect of learning with cognitive conflict-based augmented reality in increasing scientific literacy, especially in static fluid materials.

II. Literature Review

A. Augmented Reality (AR)

AR is becoming a popular three-dimensional visualization technology in education in the 21st century. The presence of AR complements the visualization of previous phenomena that were limited to the presentation of images and videos. Images and videos are able to visualize phenomena in two-dimensional form, supporting the explanation of physics material [25]. AR comes with three-dimensional visualization of the user's environment. The ability to visualize natural phenomena in their original condition through computers and smartphones is the advantage of this technology [26]. AR efficiency provides ease of use to observe objects that are difficult to observe in detail [27]. The characteristics of AR technology consist of three-dimensional visualization, real-time display, and representation of virtual objects in the real environment [12, 28].

AR attracts the world of education by presenting learning with more efficiency. This technology gained great attention in education because it became a trend, is low-cost, and is easy to use [13]. AR technology helps in explaining learning material more contextually without the need for actual physical objects [12]. The use of AR technology can also provide benefits in supporting student motivation, interest, and understanding in the learning process [29]. In its use in learning, AR encourages the improvement of students' critical 21st-century skills in secondary school learning [30]. In addition, learning with AR increases the time efficiency of teachers and students in explaining the material because students can access it repeatedly. The use of well-organized AR also supports the achievement of effective learning in accordance with the goals to be achieved.

B. Cognitive Conflict Models

The cognitive conflict model is a model that is oriented towards research and concept discovery with the aim of increasing mastery of concepts. The presentation of phenomena and experimental activities in collecting data became the hallmark of cognitive conflict models [31]. Experimental activities aim to encourage students to think deeply.

This model has been implemented in physics learning to support students' understanding of concepts. The cognitive conflict model has been widely implemented in physics learning and has had a positive effect. The cognitive conflict model has been implemented in various forms of teaching materials. Cognitive conflict models combined with video presentations in investigating phenomena encourage students' mastery of concepts [31]. The implementation of models in multimedia helps students master 21st-century skills [32–34].

Cognitive conflict models play a role in correcting student misconceptions in physics learning [35]. Research on the implementation of cognitive conflict models in supporting the improvement of scientific literacy has not been conducted. This condition provides an opportunity to research it in depth.

C. Scientific Literacy

Scientific literacy is a skill that emphasizes mastering concepts and utilizing scientific knowledge in real life. Scientific literacy is an integral part of scientific literacy in investigating, explaining, and interpreting data [1, 36]. In addition, the presentation of material in scientific literacy emphasizes context, content, and competence [1]. Context relates to the presentation of real-world phenomena. Content related to learning materials, especially in hydrostatic-related material physics. Meanwhile, competence relates to the ability to explain, investigate, and interpret data. In addition, the phenomena presented in scientific literacy are also related to global, environmental, health, and technological issues [1].

The Organisation for Economic Co-operation and

Development (OECD) results revealed that mastery of scientific literacy in Indonesia is below the standards set by the OECD from the PISA test results. The problem was identified from the results of the average score of students' scientific literacy tests which reached 386, compared to the OECD standard average of 489 [1]. This condition is supported by the results of previous studies which showed the average score of students' scientific literacy results on fluid materials was in the low category [8]. Learning that has not been oriented towards the presentation of problem problems based on phenomena in everyday life as one of the factors in students' low scientific literacy [37]. The implications of presenting material aspects of scientific literacy are still rarely applied to physics learning [38].

Physics is one part of learning science, so it is necessary to improve students' mastery of physics concepts. This condition has an impact on students' mastery of explaining, investigating, and interpreting data. Students' scientific literacy in learning fluid material physics is still low [39]. Student understanding still often experiences misconceptions and incongruities with scientific concepts [25, 33].

Scientific literacy is closely related to the contextual presentation of learning and focuses on the application of knowledge of physics to explain the phenomena of everyday life [4, 40]. In supporting the improvement of scientific literacy, it is important to focus learning on real contexts. The implementation of three-dimensional technology is urgent in presenting physical phenomena. The presence of AR technology supports realistic learning visualization in limited environments [41]. AR presents phenomena in an interactive viewpoint such as visualisation in the real environment and interacts with the object [42]. Science phenomena that are difficult to present in the learning environment can be replaced in the form of AR [43]. Further investigation of the use of technology in supporting scientific literacy needs to be investigated.

III. Methods

A. Research Design

This research uses quasi-experimental methods. Quasi-experiment is an experimental design that is carried out without randomization, but involves placing participants in several groups. This method is identical to comparing the results of the averages of the control class and the experimental class. The population of this study consisted of 5 science classes. The selection of selected research samples was carried out by random sampling. Two classes were selected: XI Science 1 and XI Science 3. All samples in the study included all students in both selected classes. Both classes are grouped into a control class and an experimental class. The design of the control class and experimental class in this study is presented in Table 1.

Table 1. Quasi-experimental methods

Class	N	Pretest	Treatment	Posttest
Control	36	Q1		Q2
Experimental	36	Q1	X	Q2

Q1 = Pretest activity, Q2 = Posttest activity, X = Learning with AR

Table 1 serves the research design of the control class and the experimental class, with each class consisting of 36 students. In the quasi-experimental method applied, three stages were carried out: pretest, treatment, and posttest activities. The initial stage provides pretests to both classes to measure students' initial abilities before learning. The second stage was learning under different conditions. In the experimental class, learning was treated to utilizing AR. In the control class, conventional learning is carried out with an approach like the original conditions of previous learning applied in schools, namely by utilizing teaching materials in the form of printed books. After both classes apply different learning processes, a posttest was carried out to measure the final ability of students. Data results from pretest and posttest as data sources from this study

B. Research Implementation

The treatment conducted in the experimental class used augmented reality teaching materials with cognitive conflict. The AR used has gone through the validity test and practicality test stages. The AR teaching materials used with cognitive conflicts have been valid and practical. In this study, further test results were reported in the form of testing the effectiveness of learning results with AR. Learning by utilizing augmented reality technology that has been designed following the stages of cognitive conflict model syntax. The learning stages designed in augmented reality based on the syntax of cognitive conflict models include 1) activation of preconceptions and misconceptions, 2) presentation of cognitive conflicts, 3) discovery of concepts and equations, and 4) reflection. The picture of augmented reality presented in the learning is shown in Fig. 1.

Fig. 1. Stages in AR teaching materials with cognitive conflict models.

Fig. 1 displays AR teaching materials presented based on the stages of cognitive conflict model syntax. Each presentation of the syntactic stages of the cognitive conflict model was presented interactively in the form of answer responses from applications and experimental activities. The preconception activation stage of AR teaching materials presents the trigger questions of student's initial abilities. The stage of presenting cognitive conflicts plays a role in presenting physics problems in an effort to train students' reasoning in analyzing solutions to problems. At the stage of discovery, concepts, and equations were presented in laboratory form as part of training the problem-solving process until drawing conclusions. AR teaching materials allow the collection of experimental data. The reflection stage plays a role in testing students' final abilities after learning and measuring the achievement of knowledge gained. Each stage in learning presents objects of physical phenomena in answering each problem in the form of AR, as presented in Fig. 2.

(a) (b) (c) (d)

Fig. 2. AR of static fluid: (a) hydrostatic pressure; (b) the Archimedes principle; (c) Pascal's principle; (d) surface tension.

Fig. 2 shows how AR was implemented to explain physical phenomena. The AR object displayed presents the phenomenon of static fluid material, as in the discussion of hydrostatic pressure, in the form of a presentation of divergent phenomena that can be varied through AR. In the discussion of the Archimedes principle, a submarine that can change its depth with AR simulation was presented. In Pascal's Principle, the brake working system of the motor was presented. Surface tension presents the state of the legs of insects when standing on the surface of the water. AR objects are displayed by pointing the camera at a marker. In each object, an explanation is given in the form of information to support the mastery of critical thinking skills. Interactivity in AR in the form of moving, zooming, and rotating objects.

C. Data Collections

The data of this study came from pretest and posttest scores of scientific literacy in the control class and experimental class. The test instrument consists of 13 complex multiple-choice questions consisting of 4 answer choices. The test instruments used come from static fluid material scientific literacy instruments that have been valid and reliable. The instrument indicators used by scientific literacy relate to the ability to explain scientific phenomena, interpret data, and conduct scientific investigations. Each question presents a selection of question-and-answer information that represents indicators of scientific literacy.

D. Data Analysis Technique

Data analysis of pretest and postest results obtained the average score of each student from answering 13 questions given in the test activity. These results are used as data for statistical testing. Statistical product and service solutions 26 (SPSS 26) for testing normality, homogeneity, Wilcoxon test, and Mann-Whitney test. The first stage carried out normality tests using the Kolmogorov-Smirnov and Shapiro-Wilk tests. The normality test aims to gain an understanding of whether the data is normally distributed or abnormal. In the second stage, the homogeneity test is carried out through the Levene test to determine whether the data is homogeneous or not homogeneous. Data that are not normally distributed and are inhomogeneous are carried out through nonparametric statistical testing through the Wilcoxon and Mann-Whitney tests. The Wilcoxon test was conducted to see the difference in the average pretest and posttest results in each class. In the Mann-Whitney test, we aim to see the average difference between the two classes. The Mann-Whitney test aims to test the hypothetical results of the study. The null hypothesis in this study states that the use of augmented reality has no effect on increasing students' scientific literacy on static fluid materials.

IV. Result and Discussion

Research data was obtained from the results of the pretest and posttest. The first statistical testing was done through normality and homogeneity tests. The normality test is performed to see the normally distributed data, while the homogeneity test is performed to find the homogeneous data. Homogeneity testing is performed using the Kolmogorov test, and the homogeneity test is performed using the statistical Levene test. The results of the normality and homogeneity tests are presented in Table 2.

Table 2. Normality test and Homogeneity test

Test	Class	Normality Test Kolmogorov-Smirnova			Homogeneity Test Levene Statistic		
		Statistic	df	Sig.	Statistic	df	Sig.
Pretest	Control	0.219	36	0.000	1.670	70	0.200
	Experimental	0.165	36	0.015			
Posttest	Control	0.277	36	0.000	5.455	70	0.22
	Experimental	0.361	36	0.000			

Table 2 shows the normality and homogeneity test results of the pretest and posttest results in the control class and experimental class. Drawing conclusions of normal and homogeneous data if the sig value is greater than 0.005. The data results indicate that the distribution of data on the pretest and posttest of both classes is not normally distributed. While the data results on the pretest data are homogeneous, and the data on the posttest data is homogeneous. Abnormal and homogeneous data information provides further statistical test selection information through Wilcoxon and Mann-Whitney tests in the control class and experimental class.

The results of the control class and experimental class pretest and posttest data were carried out with dependent testing. Dependent testing in the control class and experimental class aims to measure the difference in pretest and posttest results after being treated with conventional learning and utilizing augmented reality. Statistical testing was conducted through the Wilcoxon test to obtain information on the effect of learning on control classes and experimental class. Wilcoxon test results from the control class and experimental class pretest and posttest results are presented in Table 3.

Table 3. Control class and experimental class Wilcoxon test results

Information	Control class	Experimental class
	Posttest-Pretest	Posttest-Pretest
Negative Rank	0	0
Positive Rank	36	36
Ties	0	0
Total	36	36
Z valu	−0.5264	−0.5254
Asymp. Sig (2 tailed)	0.000	0.000

Table 3 presents Wilcoxon test results from students' pretest and posttest score data before and after learning in the control class and experimental class. In the control class, the negative rank value of the posttest results against the pretest was 0, which means that there was no decrease in score on the posttest. Meanwhile, the positive rank value of 36 means there was an increase in scores in 36 samples. While ties are zero, it indicates that there was no equal score between the pretest and posttest. The z value was −5.264, and the assumed Sig (2-tailed) value was 0.000, which was smaller than 0.05. The results of the sig two-tailed score revealed that conventional learning gave students an increase in scientific literacy. Conventional learning has a positive effect on scientific literacy.

In the experimental class, the negative rank value of the posttest results against the pretest was 0, which means that there is no decrease in score on the posttest. Meanwhile, the positive rank value of 36 means there is an increase in scores in 36 samples. While ties are zero, it indicates that there was no equal score between the pretest and posttest. The z value was −0.5254, and the assumed Sig (2-tailed) value was 0.000, which was smaller than 0.05. The results of the sig 2-tailed score revealed that conventional learning gave students an increase in scientific literacy. Learning by utilizing AR has a positive effect on scientific literacy.

The average score results from the experimental class posttest and the control class posttest obtained significant scores compared to the pretest score. The results of scientific literacy scores were spread on indicators of the ability to explain scientific phenomena, conduct investigations, and interpreting scientific data. There were differences in score results in experimental classes that were treated by learning to use augmented reality with control classes carried out by conventional learning. A comparison of differences in students' posttest results based on each indicator of scientific literacy was presented in Fig. 3.

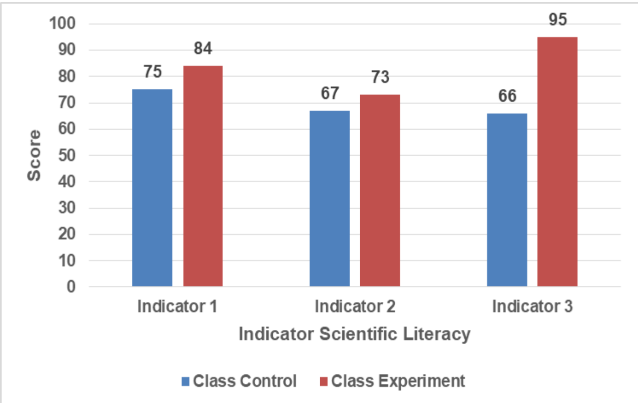

Fig. 3. Comparison of test results of each indicator.

Fig. 3 serves the difference in students' posttest score results after being given different treatments. In indicator 1, which relates to the ability to explain scientific phenomena, a score of 75 was obtained for the control class and 84 for the experimental class. In indicator 2, which relates to the ability to investigate scientific phenomena, a score of 67 was obtained for the control class and 73 for the experimental class. In indicator 3, which relates to the ability to interpret data, a score of 66 was obtained for the control class and 95 for the experimental class. The experimental class, which used learning by utilizing augmented reality, obtained higher scores compared to the control class that used conventional learning. Hypothesis testing with the Mann-Whitney test was performed to see the significant effect of independent data. The results of the Mann-Whitney test are presented in Table 4.

Table 4. Mann-Whitney test results

Test	Result
Mann-Whitney U	105.000
Z Value	−6.345
Sig (2-tailed)	0.0000

Table 4 gives a Mann-Whitney U score of 105.000, which shows a significant difference in scores between posttest results in the experimental class compared to the control class. At a significance level of 0.05, the calculated Z-value must be less than -1.96 for the null hypothesis to be rejected. The result of the Z value obtained was −6.345, much smaller than the Z value of the table. The rejection of the null hypothesis occurs when the two-sided significance value was smaller than 0.05, and the calculated Z value is smaller than table Z. In this case, the result of the two-sided significance value and the Z-value obtained is much smaller than the established standard value, so the null hypothesis can be rejected. The conclusion of this test is that learning by utilizing AR effectively increases students' scientific literacy compared to conventional learning.

The results of the research found present a new picture compared to previous researchers. Interactive presentation in learning by utilizing AR supports scientific literacy. In line with previous researchers, revealing teaching materials presented in interactive form supports the scientific literacy of fluid material [44]. The presentation of new implications of AR supports scientific literacy. Previous researchers focused on AR research highlighting interest, motivation and increased learning outcomes by utilizing AR media [26, 45, 46]. Unlike previous research. New implications by utilizing interactive cognitive conflict-based AR improve static fluid material scientific literacy.

AR implemented with cognitive conflict models supports changes in the results of students' scientific literacy abilities. Cognitive conflict was related to the presentation of scientific literacy information that encourages students to think deeply. The presence of AR technology supports a concise and simple explanation of static fluid material. AR learning interventions with cognitive conflict present significant differences in mastery of the ability to explain, interpret data and support scientific inquiry after learning.

The use of technology was an effective solution to support the improvement of students' scientific literacy. Technology enables better delivery of information in a variety of forms. The results showed an increase in mastery of scientific literacy that was better than conventional learning. AR is presented in the form of interactive simulations related to static fluid phenomena, with explanatory captions on each object and buttons to move objects, helping students develop the ability to explain static fluid phenomena. Supports the processing of real objects and streamlines the learning process through the visualization of three-dimensional objects [47]. The interactivity of observation and explanation in AR encourages the delivery of information in explaining, investigating, and interpreting data from the observation process in accordance with indicators of scientific literacy. AR supports this learning most actively and is easy to use to support the learning process [48, 49]. Learning by utilizing augmented reality helps students improve concepts in physics learning [50]. These findings were in line with previous research that revealed the use of AR has a positive effect on student learning outcomes and learning attitudes [45, 51]. The presence of technology also supports exploration in investigating phenomena in the field of physics, including fluids. Therefore, students' scientific literacy can be improved through the use of technology. This technology has the capability to present real objects and events in learning in a structured and simpler way.

The use of AR in learning brings significant efficiency and effectiveness. Learning using AR has proven effective in delivering material in a simple and easy-to-understand manner. AR creates a more engaging learning experience by allowing three-dimensional objects to appear in the real environment, creates a more engaging learning experience. In addition, this learning can increase student interest and motivation in the learning process [29, 46]. The AR presentation displays realistic physics objects in a real-world context, which stimulates students' curiosity to explore physics materials through the AR objects presented. Visualization of objects helps improve students' scientific literacy in explaining and investigating physical phenomena. The use of AR in physics learning provides various advantages in improving the quality of learning and student learning outcomes [52, 53].

Each stage of the cognitive conflict-based learning model syntax plays an important role in supporting students' mastery of scientific literacy. AR provides an explanation and detail of each phenomenon in each syntax of the cognitive conflict-based learning model. Learning material information is explained in the form of a three-dimensional presentation displayed through augmented reality. At the activation stage of preconceptions and misconceptions, the main role is to test students' initial understanding of learning. This stage serves to assess the initial ability of students in the learning process [24]. Learning activities at this stage involve answers to questions related to the phenomenon of static fluid material. With the application of AR, students can check their answers and get explanations from the discussion in the form of augmented reality presentations.

The presentation of cognitive conflict is the second stage in the syntax of the cognitive conflict model. This stage plays a role in bringing out students' hypothetical abilities to practice critical thinking skills. The presentation of phenomena and information at the cognitive conflicts stage aims to cause conflicts in students' thinking. With the AR application, students' initial answers can be saved and sent to the teacher. This allows teachers to evaluate the extent of students' mastery of the skills. AR serves to explain the presentation of information that causes conflict simply to students by displaying Augmented Reality animations. Complex and intricate information presentations can be conveyed more simply with augmented reality technology so that students can easily understand phenomena and interpret observed information more quickly. Visualization of phenomena in the presentation of cognitive conflicts aims to encourage students to multiply information more sharply to explain the phenomenon [33, 54]. Learning with AR allows students to explore, observe, and simulate physical phenomena, helping students to explain physics material more specifically [12]. Concept discovery and experimentation are the third stages of the cognitive conflict model. This stage plays a role in training students to investigate phenomena scientifically to prove hypotheses. The application of AR allows students to conduct experiments virtually and collect data using smartphones. Laboratories and experimental activities play a role in helping students obtain data and interpret it [55, 56]. This condition plays a role in training students' scientific literacy and interpreting information based on data.

The fourth stage of the model is reflection. Feedback from each stage applied in augmented reality becomes a solution to measure students' mastery of skills. Improvement of concepts and mastery of deep thinking skills are indications of achieving student learning outcomes in the fallacy of this model. With feedback from each phase in the use of AR, it allows for a more accurate evaluation of students' understanding and abilities. The process of refining concepts and mastering deep thinking skills through AR also provides a more precise picture of students' achievement of learning outcomes, ensuring that these models contribute to their cognitive development effectively [57]. This model encourages students to gain a solid scientific understanding according to the original concept. This situation impetus the development of students' scientific literacy. The use of augmented reality, which applies AR technology in the context of learning, has a significant positive impact on improving students' scientific literacy. Therefore, the application of this technology is recommended in physics learning to explain the material more effectively and efficiently. Learning with the presentation of visualization material in the form of AR contributes to providing a detailed explanation of the material. AR provides novelty to the world of education with the presence of technology integration as an innovative medium in learning

V. Conclusion

The results showed that classes with conventional learning and classes with learning utilizing augmented reality on static fluid material both experienced improved learning outcomes. Both classes obtained improved results in scientific literacy on fluid materials. Learning with AR based on cognitive conflict has a greater effect than conventional learning in improving students' scientific literacy and fluid material. The results of the hypothesis test revealed that learning by utilizing augmented reality based on cognitive conflict is effective compared to conventional learning. Visualization of static fluid phenomena implemented in the syntax stages of cognitive conflict models in the form of augmented reality helps in explaining phenomena, interpreting data and conducting investigations. Thus, learning by utilizing augmented reality is effectively used to improve students' scientific literacy of static fluid material.

The limitation of this study lies in the use of markers to display three-dimensional objects. Researchers can further enhance the immersive of augmented reality in the form of virtual reality or mixed reality. In addition, the observation aspect is limited to the literacy of static fluid material. Other researchers can also measure other 21th century interests, attitudes and skills.

Appendix

Table A. Scientific literacy indicators

Indicator 1	Explain scientific phenomena related to static fluid matter
Indicator 2	Conduct investigations and experiments related to static fluid materials
Indicator 3	Interpreting scientific data related to static fluid matter information

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Fatni Mufit contributed articles and provided research ideas, data analysis and data interpretation. Muhammad Dhanil contributed to collecting data and processing and creating articles. All authors had approved the final version.

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