

# Development of science modules assisted with augmented reality to improve science literacy of junior high school students

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**Abstract:** This study aims to develop an augmented reality (AR)-assisted science learning module that is valid, practical, and effective in improving the science literacy of junior high school students. Science literacy enables students to understand scientific concepts, explain phenomena scientifically, and use scientific evidence to solve problems in everyday life. However, the level of science literacy among students in Indonesia is still relatively low, partly due to the use of conventional teaching materials that do not optimally utilize digital technology. Therefore, the development of technology-based teaching materials is needed to support more effective science learning. This research employed a research and development method using the ADDIE model, which includes analysis, design, development, implementation, and evaluation stages. The subjects were 28 students of class VIII A at State Islamic Junior High School 2 Jember. The research instruments consisted of expert validation sheets, learning implementation observation sheets, student response questionnaires, and pre-test and post-test to measure students' science literacy improvement. The results showed that the AR-assisted science module obtained a validity score of 83% (very valid), a practicality score of 85% (very practical), and an effectiveness level indicated by an N-gain score of 0.71 (high category). Student responses reached 84% in the good category. These findings indicate that the AR-assisted science module is feasible and effective as an innovative teaching material to improve students' science literacy on the topic of the human respiratory system.

**Keywords:** augmented reality; development; module; respiratory system; science literacy

## 1. Introduction

Literacy is a major topic that is often discussed in the field of education. This is because the role of literacy is a crucial part of education. The role of literacy as the main focus certainly has important consequences for the implementation of literacy programs in schools [1]. Literacy is defined as a person's ability to understand events in life. Literacy skills, namely the ability to read and write, are an important focus in using a learning medium as a person's preparation in life [2]. There are six types of basic literacy, namely literacy in reading and writing, numeracy literacy, science literacy, digital literacy, financial literacy, and cultural and civic literacy. Each literacy has an important role in equipping individuals to face challenges in the global era [3].

Science literacy skills are the ability to understand scientific facts by applying science and technology to solve problems in real life [2]. Science literacy is the first

step to broaden and deepen understanding of scientific concepts. Science literacy is not only learning about theory but also being trained to understand and apply scientific concepts through reading scientific literature, writing research reports, and conducting experiments and practicing science directly [4]. Science literacy can be considered how learners understand the scientific context, the extent of their competence in using the scientific method, and the depth of their knowledge of science concepts [5].

The level of science literacy in Indonesia is still ranked low with an unsatisfactory average score [6]. This is reinforced by the findings from the research of Humairah et al. that the science literacy of Ibrahim 3 Sukorejo Junior High School students in science content is still low at 55.9%, science process at 54.80%, and science context at 57.4% [7]. The low level of science literacy in Indonesia is also supported by research conducted by Distrik et al. [8], which shows that students still have difficulty in understanding problems, explaining scientific phenomena, and drawing conclusions from evidence relevant to science learning. In addition, they also have not been able to connect the ideas they have with the problems presented in learning. Low science literacy is caused by several factors, one of which is learning that focuses more on memorizing material rather than practical application in real life. In addition, learning also lacks emphasis on aspects of science discovery and direct exploration of science [9].

The results of interviews with science subject teachers of State Islamic Junior High School 2 Jember on 30 August 2024 support this fact. It is known that there are still some students during science learning who have difficulty understanding science concepts in science literacy activities. This difficulty can be caused by various factors, including lack of direct experience, lack of adequate explanation, or inability to connect science concepts with everyday phenomena. In addition, the teaching materials used in learning are still textbooks that have been provided by publishers and have never utilized modern technology.

Literacy skills encourage learners to think creatively and find innovative solutions to problems. A good understanding of science can make the younger generation more prepared to find solutions to various problems in everyday life, ranging from environmental problems and health to technology. Therefore, a learning approach is needed with the help of some teaching materials that are more effective in improving scientific understanding and scientific literacy so that students can be more competent in facing future challenges [5].

Facts in the world of education today show that many teachers still rely on conventional teaching materials, namely teaching materials that have been provided by publishers. This less flexible approach can hinder the effective learning process [10]. Professional teachers have the ability to recognize various factors that can foster interest and increase student motivation [11]. The availability of quality teaching materials is one of the key factors in achieving effective and literacy-based learning. Learning modules are an effective type of teaching material, especially in encouraging independent learning [2]. Modules have characteristics, including being self-instructional, self-contained, stand-alone, adaptive, and user-friendly [12]. The material of the human respiratory system in Natural Science (IPA) lessons often faces

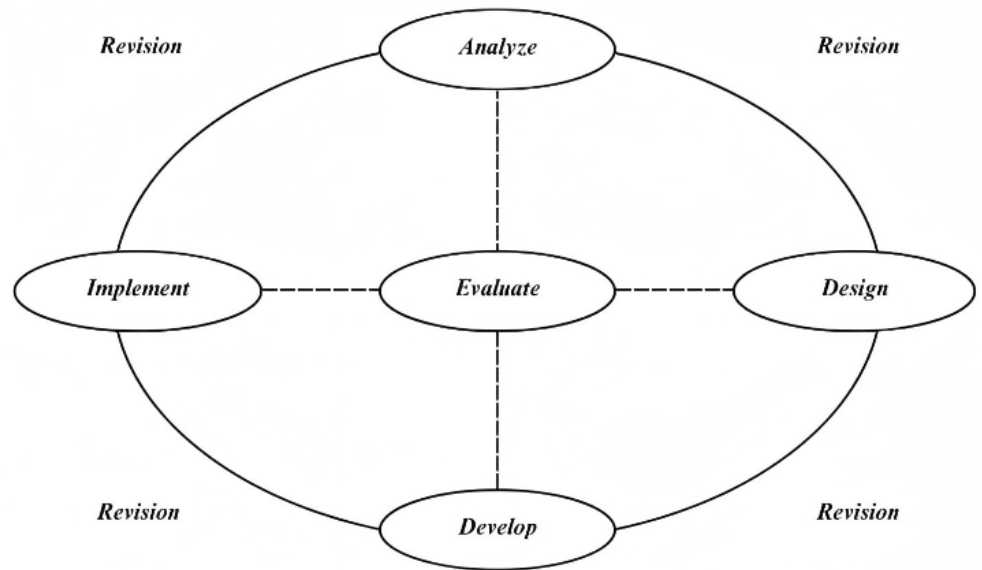
various challenges, especially because of its abstract and complex nature, so it requires effective learning media to describe the material because it cannot be observed directly. Some of the media used still have shortcomings, such as blurred illustrations and incomplete teaching aids at school [13].

The advancement of science and technology today has a significant impact on the world of education. Technology utilization helps develop learners' skills in using technological tools to access, understand, and interpret scientific information [14]. One example of the application of technology in education is by integrating various digital tools and platforms into teaching methods [15]. Augmented reality (AR) is an innovative technology that combines digital elements with the user's real world. Data and information from the virtual world are displayed on top of real objects, creating a more immersive and interactive experience. Augmented reality can produce an experience where users can interact directly with digital information displayed in the context of the user's real world [1]. According to Abildinova et al. [16], in the development of augmented reality applications there are three main components needed, including computers as control devices, markers as images used by computers to track positions, and cameras as recording sensors. The use of augmented reality in learning allows the display of 3D objects of respiratory organs displayed through markers in the module so that students can see the visualization of virtual objects about the human respiratory system directly [13].

Based on the description above, researchers are trying to develop a science module that can provide real visual effects with the help of augmented reality technology combined with images and text contained in the module. Of course, with a touch of technology, it is hoped that students can improve their science literacy skills and understand scientific concepts well. Therefore, researchers are interested in conducting research with the title "Development of Science Modules Assisted with Augmented Reality to Improve Science Literacy of Junior High School Students".

## **2. Materials and methods**

Researchers adopted the ADDIE model development research, which aims to produce a science module assisted with augmented reality that is valid, practical, and effective to improve the science literacy of junior high school students on respiratory organs material. The ADDIE model consists of five stages, namely analysis, design, development, implementation, and assessment. The research was conducted at State Islamic Junior High School 2 Jember in class 8 semester 1 of the 2024/2025 school year. The population used for this study is class VIII students of State Islamic Junior High School 2 Jember. The sample of this study was 8A class students, totaling 28 students. The sample selection was carried out using a purposive sampling technique with the criteria of academic level variation based on exam scores or report cards of previous learning outcomes. The selection of samples based on variations in academic levels refers to differences in students' academic abilities determined through test scores or reports on previous learning outcomes. The following **Figure 1** displays the model of the ADDIE development.



**Figure 1.** ADDIE development model [17].

The first stage is analysis, namely analyzing needs and curriculum through observation and interviews. The second stage is design, which is the design of augmented reality-based science modules using Microsoft Word and Assemblr Edu, including the making of module covers and contents. The third stage is development, which is the validation of the module by three validators to ensure quality and conformity with the curriculum. The fourth stage is implementation, namely the module trial to 28 students of class 8A at State Islamic Junior High School 2 Jember to determine the effectiveness and student response to the AR-based module. The last stage is evaluation, namely module revision based on input from validators, observers, and students so that the module becomes a more effective learning resource and in accordance with technology-based learning needs.

Data collection techniques in this study included several methods. Observation is a method of collecting data before research to obtain optimal results in product development. Interviews were conducted openly with science teachers at State Islamic Junior High School 2 Jember to find initial information. Documentation serves to collect and support data obtained in research. The validation sheet is an instrument to evaluate the quality of the module so that it can be valid and feasible to be applied. The observation sheet is an instrument to determine the practicality of the augmented reality-assisted science module, and the test in this study consisted of a pre-test and a post-test, which were distributed to students to determine the science literacy of students.

Data analysis techniques in this study include validity test analysis, practice test analysis, and effectiveness test analysis. Product validation data analysis uses the following formula:

$$P = \frac{T_{SE}}{T_{SM}} \times 100\%$$

Description:

$P$  = validity percentage;

$T_{SE}$  = total score achieved;

$T_{SM}$  = total maximum score.

The results of the analysis were then interpreted as in the **Table 1** of validity criteria by Ismawati and Fuadi [18].

**Table 1.** Validity criteria.

Assessment (%)	Criteria
0%–20%	Invalid
21%–40%	Less Valid
41%–60%	Valid enough
61%–80%	Valid
81%–100%	Very Valid

Product practicality is obtained from the results of observations of learning implementation. Data analysis of product practicality uses the following formula:

$$P = \frac{\sum T_{Se}}{\sum T_{Sh}} \times 100\%,$$

Description:

$P$  = practicality percentage;

$T_{Se}$  = total score achieved;

$T_{Sh}$  = total maximum score.

The results of the analysis were then interpreted as in the **Table 2** of practicality criteria by Muskhir et al. [19].

**Table 2.** Practically criteria.

Assessment (%)	Criteria
0%–20%	Impractical
21%–40%	Less Practical
41%–60%	Practical Enough
61%–80%	Practical
81%–100%	Very Practical

The effectiveness test consists of two types of analysis, namely analysis of science literacy test results and analysis of student response questionnaires. The analysis of the science literacy test was carried out using the N-gain calculation to determine the extent of the improvement of students' science literacy skills. The N-gain formula [20] is as follows:

$$N\text{-gain } < g > = \frac{S_{\text{post-test}} - S_{\text{pre-test}}}{S_{\text{maksimal}} - S_{\text{pre-test}}}$$

After the scores are normalized, the results are compared with the N-gain category based on the criteria from Wahyuningsih and Hikmat [20] in the **Table 3** below.

**Table 3.** N-gain criteria.

Score	Criteria
$g > 0.70$	High
$0.30 \leq g \leq 0.70$	Medium
$g < 0.30$	Low

Analysis of student response questionnaires was calculated using the following formula:

$$RS = \frac{\Sigma X}{N} \times 100\%$$

Description:

$RS$  = percentage of effectiveness;

$\Sigma X$  = total score achieved;

$N$  = maximum score.

After obtaining the percentage of effectiveness, it is then compared with the validity category based on the criteria from Suastika and Rahmawati [21] in the **Table 4** below.

**Table 4.** Effectiveness criteria.

Assessment (%)	Criteria
85–100	Excellent
75–84	Good
60–74	Good enough
40–59	Less Good
0–39	Not good

### 3. Results and discussion

#### 3.1. Analysis

The first stage is the analysis stage. The analysis stage at State Islamic Junior High School 2 Jember involved evaluating students' needs and the curriculum, starting with observations to gather information about students' difficulties and resource needs. The results of structured interviews conducted with one of the science teachers at State Islamic Junior High School 2 Jember class VIII have provided an overview of the implementation of science learning, including the use of media, the application of technology, and the integration of science literacy. The following is a list of questions and answers from the teacher.

Question 1: What curriculum is used at school?

Answer: Independent curriculum.

Question 2: What are the media used in learning?

Answer: Adapted to the learning topic.

Question 3: Have you applied the help of augmented reality technology in learning science, especially the material of the human respiratory system?

Answer: Not yet.

Question 4: Do you find difficulties in integrating science literacy from some

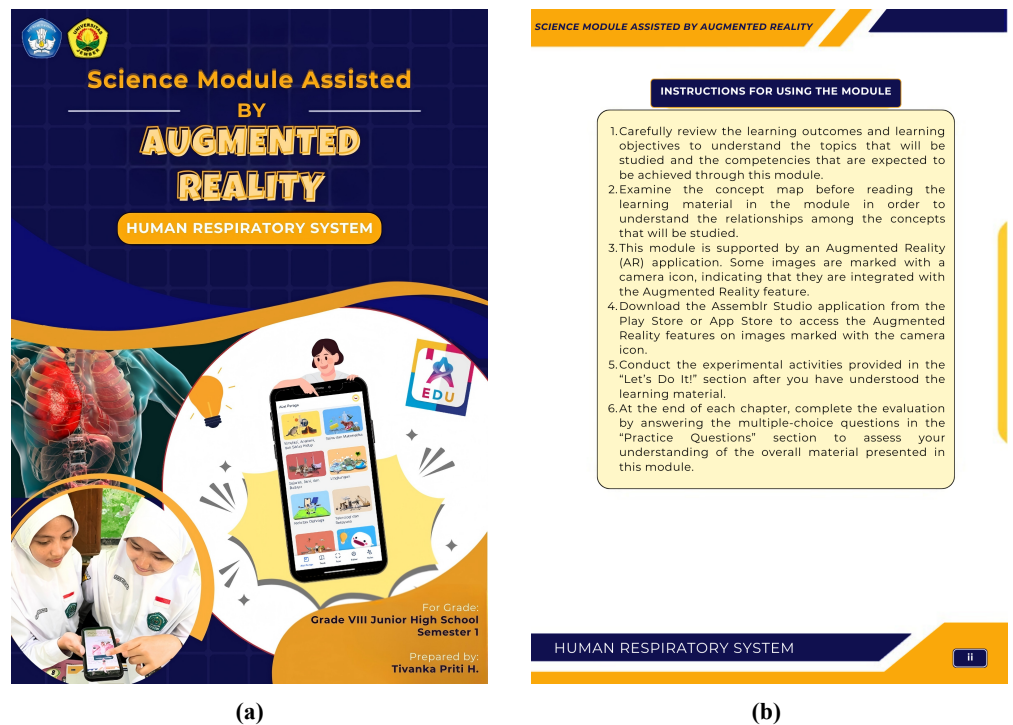
students?

Answer: Students in this school are heterogeneous, so the ability of students to accept some material will definitely have difficulties, so special assistance is needed.

Based on the results of interviews with science teachers at State Islamic Junior High School 2 Jember, it is known that learning has used the Merdeka Curriculum with customized media based on the topic. However, augmented reality (AR) technology has not been applied in the science learning process. The teacher also said that in integrating science literacy, there are obstacles due to the heterogeneous abilities of students, so that some students have difficulty understanding the material and need special assistance. These findings indicate an opportunity to develop an interactive AR-assisted science module to help students' understanding of science concepts in a more visual and interesting way.

### 3.2. Design

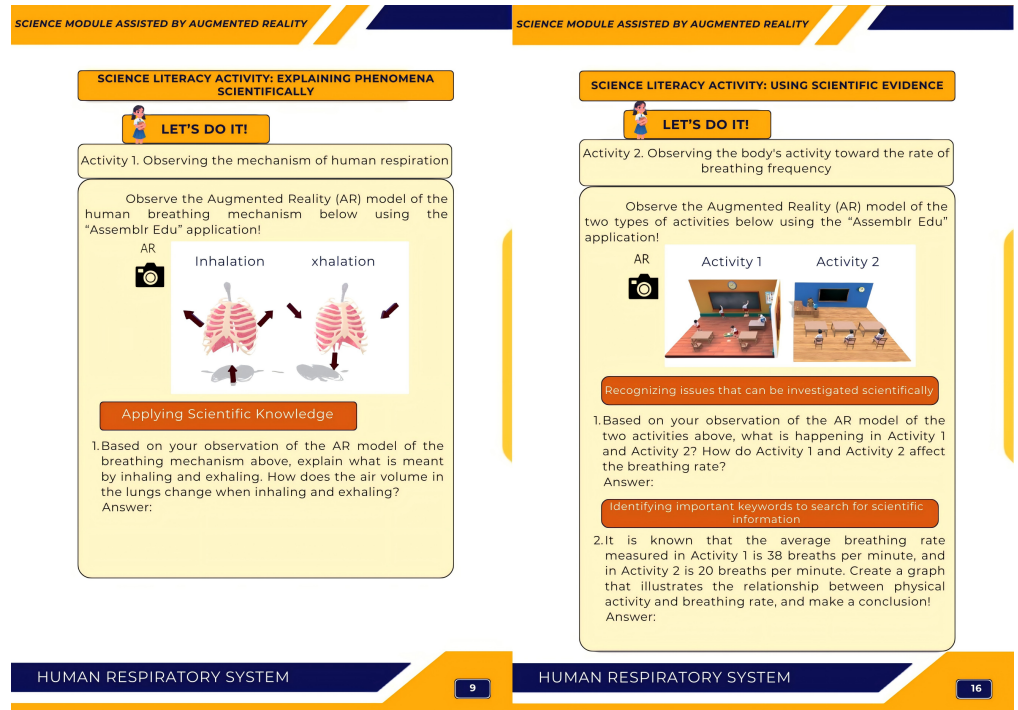
The second stage is the module design stage using Canva and Microsoft Word. The design stage begins with designing the cover page as attractive as possible using the Canva application with a blue background that is equipped with an image of the human respiratory system, a 3D augmented reality image of a student conducting research, and the first page of the Assemblr Edu application. Furthermore, designing templates, module layouts, and colors, structuring cohesive material; and selecting font types and sizes using Microsoft Word. The following **Figure 2a** displays the module cover and **Figure 2b** shows the instructions for using the module.



**Figure 2.** (a) Module cover; (b) Module instructions for use.

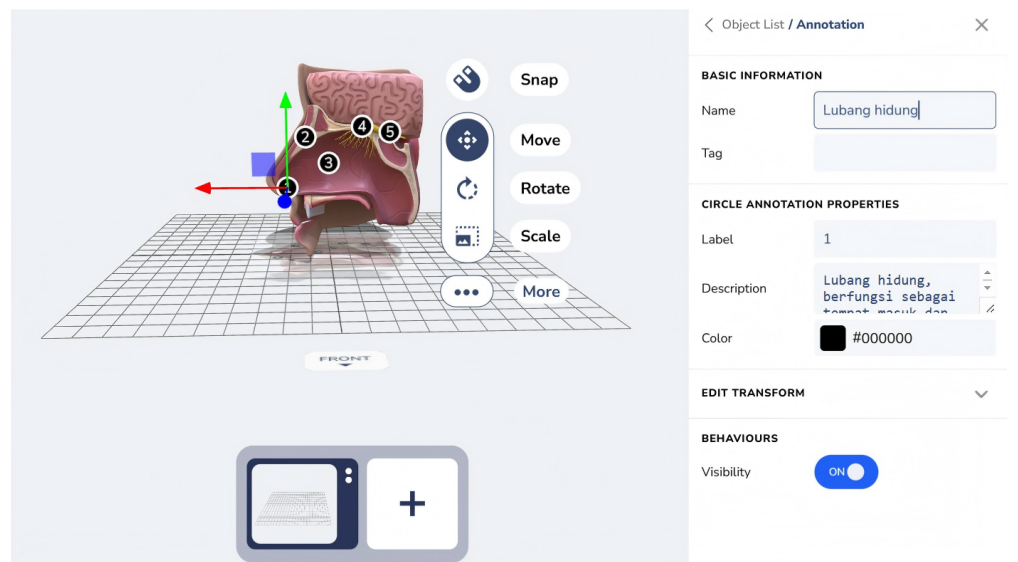
Science literacy indicators that include identifying science issues, explaining phenomena scientifically, and using scientific evidence are included in the preparation of the module in order to meet the objectives of the human respiratory

system material. **Figure 3** shows the science literacy activities in the module.



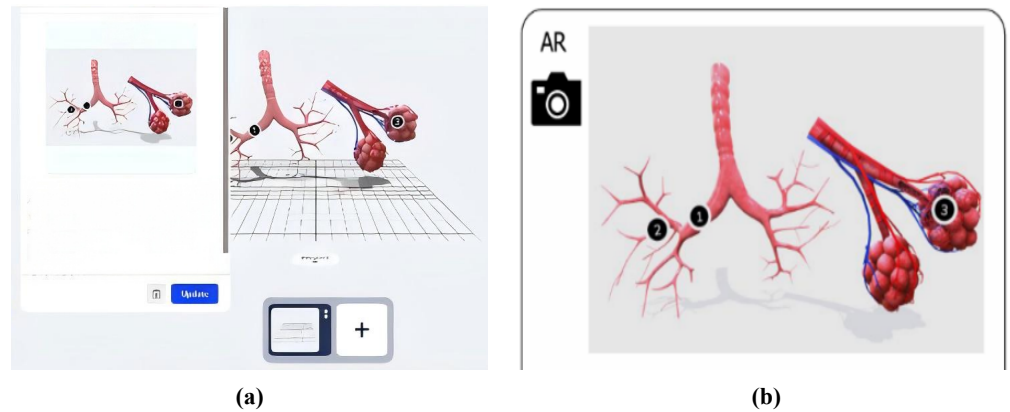
**Figure 3.** Science literacy activities in the module.

Making augmented reality images is designed through Assemblr Edu. Researchers are looking for the components needed in compiling augmented reality images, which are then designed using Assemblr Edu. **Figure 4** displays the creation of augmented reality.



**Figure 4.** Making augmented reality.

Next is the creation of markers to make it easier for students to access images via smartphones. The marker used is a custom marker, which is an image uploaded to serve as a special marker that can later be accessed by students. The following **Figure 5a** displays the creation of custom marker and **Figure 5b** displays the markers in the module.



**Figure 5.** (a) Custom marker creation; (b) Markers in the module.

### 3.3. Development

The next stage is the development stage. The module that has been designed will then be validated by the validator. The development stage includes validation of the modules that have been developed, can be seen in **Table 5** below.

**Table 5.** Module validity analysis.

Assessment (%)	Interval score			Percentage (%)	Criteria
	V1	V2	V3		
Format	0.88	0.8	0.8	83%	Very valid
Language	0.89	0.8	0.91	87%	Very valid
Content	0.8	0.8	0.88	83%	Very valid
Graphics	0.86	0.74	0.86	82%	Very valid
Average	0.86	0.79	0.86	83%	Very valid

Based on the results of the augmented reality-assisted science module validation in the table above, the average of the three validators obtained a percentage of 83% with a very valid category, so it can be concluded that the augmented reality-assisted science module that has been designed is feasible and can be used in classroom learning.

### 3.4. Implementation

The implementation stage is the stage of testing product development in the form of augmented reality-assisted science modules that have been validated into learning. Learning implementation observation data is used to evaluate the implementation of the use of augmented reality-assisted science modules during the learning process. The results of observations of learning implementation can be seen in **Table 6** below.

**Table 6.** Practicality analysis results.

Autorship criteria	Meeting			Average (%)	Criteria
	1	2	3		
Direct and active involvement of learners in the learning process	87	87	87	87	Very practical
Learners can do initial understanding by reading chapters in the augmented reality-assisted science module	87	87	87	87	Very practical
Learners can operate the Assemblr Edu application when observing augmented reality in the module	80	80	87	82	Very practical
Learners can understand the science literacy activities in the activities available in the module	87	87	80	85	Very practical
Learners are able to cooperate well with their group members to observe augmented reality in group activities	87	80	80	82	Very practical
Average	86	84	84	85	Very practical

The results of the learning implementation observation analysis from the table above obtained an average percentage of 85% with a very practical category. The results of observations of the implementation of learning using science modules assisted by augmented reality each meeting reached a very practical category. This shows that the science module aided by augmented reality is practically used in science learning.

### 3.5. Evaluation

The evaluation stage is used to measure the effectiveness of the augmented reality-assisted science module obtained from the pre-test and post-test results to obtain data on the improvement of students' science literacy by conducting the N-gain test. Besides that there is a student response questionnaire sheet to obtain data on the analysis of student responses after using the product. Data for N-gain criteria can be seen in the following **Table 7**.

**Table 7.** N-gain score results of science literacy indicators.

Component	Pre-test	Post-test	N<g>	Criteria
Number of students	28	28		
Lowest score	44	72	0.71	High
Highest score	69	97		

The results of the N-gain analysis of student science literacy tests in **Table 7** obtained 0.71; it can be concluded that there is an increase in student science literacy after being given treatment in the form of application of science modules assisted by augmented reality on the material of the human respiratory system with a high category. The results of the analysis of the effectiveness of the use of augmented reality-assisted science modules with N-gain based on each indicator of science literacy can be seen in the following **Table 8**.

**Table 8.** Results of pre-test and post-test N-gain scores.

Science literacy indicators	Science literacy sub indicators	Average score		N-gain	Description
		Pre-test	Post-test		
Identifying science issues	Recognize the issue under scientific investigation	78	88	0.45	Medium
	Identify keywords to look up scientific information	29	85	0.79	High
	Recognize the stages of scientific inquiry	32	69	0.54	Medium
Explaining phenomena scientifically	Applying scientific knowledge	56	92	0.82	High
	Interpreting the phenomenon	44	69	0.45	Medium
	Identify explanations and hypotheses	88	99	0.92	High
Using scientific evidence	Identifying assumptions	83	95	0.71	High
	Interpret scientific evidence and provide conclusions	37	93	0.89	High
	Reflecting on the social implications of science and technology developments	50	93	0.86	High

The results of the calculation of the N-gain value of each indicator of science literacy obtained show that students' science literacy has increased after using the augmented reality-assisted science module. The effectiveness of augmented reality-assisted science modules is assessed through student response questionnaires to learning and modules. The results are presented in the following **Table 9**.

**Table 9.** Results of effectiveness analysis based on student response questionnaire.

Aspects	Percentage (%)	Criteria
Assessment of Learning Activities with Science Modules Assisted with Augmented Reality	82	Good
Assessment of the module used	86	Very good
Average	84	Good

The results of the analysis of student response questionnaires after using the augmented reality-assisted science module showed an average percentage of 84% in the good category. The results of the assessment of each aspect also obtained a different category, with the percentage of aspects of the assessment of learning activities with augmented reality-assisted science modules at 82% and the percentage of aspects of the module assessment used at 86%.

## 4. Discussion

### 4.1. Validity

The augmented reality-assisted science module is a product that has been developed through development research using the ADDIE development model. This development product was validated by three validators, namely one science teacher at State Islamic Junior High School 2 Jember and two science education lecturers at the University of Jember. Based on the average validation results in **Table 5**, a percentage of 83% was obtained with a very valid category, indicating that the product that has been developed is valid for use in learning. This is because the science module assisted by augmented reality has met the eligibility requirements in each aspect that can be declared valid if it reaches an average score  $\geq 61\%$ .

The components of the science module that are validated by validators include format aspects, language aspects, content aspects, and graphical aspects. The percentage of validation results in the format aspect reached 83%, which was categorized as very valid. The module that has been developed contains a clear numbering system, the design of the space and layout is well arranged, and the type and size of the font are not excessive. This is in line with the findings of Hanggara et al. [22], who emphasized that a good module should include a complete structural composition, an attractive and engaging design, and appropriately scaled dimensions tailored to students' needs. These aspects are essential not only to support readability but also to ensure user convenience and effective storage. Therefore, the validation result obtained confirms the quality indicators mentioned by Hanggara et al., strengthening the validity of the module format. The results of validation in the language aspect obtained a percentage of 87% with a very valid category. The developed module uses communicative language, simple language preparation, and linguistic rules. This is in line with the opinion of Doz et al. [23], who said the results of the module development were declared to have elements of feasibility in terms of language if the language used was more communicative and adjusted the rules for using Indonesian.

The percentage of validation results on the content aspect reached 83%, which was categorized as very valid. This shows that the product that has been developed,

namely the augmented reality-assisted science module on the material of the human respiratory system, has the truth of the material, clear learning outcomes, renewability according to the applicable curriculum, namely the independent curriculum with science literacy skills, and the preparation of coherent material. The augmented reality-assisted science module developed contains various student activities designed to achieve learning objectives. Each activity is systematically organized to include indicators and sub-indicators of science literacy. Activity 1 focuses on the science literacy indicator of explaining phenomena scientifically, where students are directed to observe the mechanism of breathing in humans. Activity 2 refers to the indicator of using scientific evidence, where students are directed to observe body activity on the frequency rate of breathing. Meanwhile, activity 3 refers to the indicator of identifying science issues, where students are directed to observe physical changes in the lungs due to harmful substances in cigarettes. In line with the research of Ghufron et al. [24], who said that the content validation aspect includes suitability with the development of science and ability indicators that will be applied.

The percentage of validation results on the graphic aspect reached 82%, which was categorized as very valid. This shows that the developed module has an attractive image design with clear resolution, a clear augmented reality display, and the color combination of images with text in the appropriate module. According to Doz et al. [23], the developed module must consider several elements such as format, visual design, font size, and consistency so that it is expected that the function and role of the module to achieve effective learning can be fulfilled.

#### **4.2. Practicality**

The trial of augmented reality-assisted science modules that have been developed in learning science material of the human respiratory system is carried out for 5 meetings. The 1st and 5th meetings were the pre-test and post-test meetings, while the 2nd, 3rd, and 4th meetings were the learning activities using the augmented reality-assisted science module. In learning activities using augmented reality-assisted science modules, there are 3 observers who observe using the learning implementation observation sheet. The practicality of the augmented reality-assisted science module can be known through the results of the learning implementation observation sheet. Based on the results of the observation of the implementation of learning in **Table 6**, a percentage of 85% was reached, which included a very practical category. This shows that the augmented reality-assisted science module developed has been successfully implemented well. During the learning process, students look active, especially when using the augmented reality feature. Students are able to do initial understanding independently, able to access and operate the Assemblr edu application, and able to work well with their group members to carry out science literacy activities in the module. These findings are supported by Chetry [25], who stated that learning tools are considered practical when they can be easily used and implemented effectively. The seamless integration of the module into classroom activities, along with students' high engagement and independent interaction with the AR feature, reflects the practicality characteristics described by Harjuni et al., confirming the module's ease of use and

alignment with classroom needs.

### 4.3. Effectiveness

The effectiveness of augmented reality-assisted science modules to improve students' science literacy on the material of the human respiratory system is obtained through the test results in the form of pretests and posttests of students of class VIII A at State Islamic Junior High School 2 Jember, with a total of 28 students, as well as student response questionnaire sheets. The test was used to measure the increase in science literacy of students after using science modules assisted by augmented reality. Science literacy indicators include identifying science issues, explaining phenomena scientifically, and using scientific evidence. After obtaining data from the results of the pre-test and post-test, students will then do the calculation of N-gain to determine the increase in students' science literacy.

The results of the analysis conducted with the N-gain score on the pre-test and post-test obtained an increase through an average N-gain of 0.71, which according to Wahyuningsih and Hikmat [20], is the acquisition of an N-gain of 0.71, including the high category. This means that students' science literacy has increased so that augmented reality-assisted science modules can be said to be effectively used as teaching materials on human respiratory system materials to improve students' science literacy. Augmented reality-assisted science modules are said to be effective because they are arranged systematically by including activities that focus on indicators and sub-indicators of science literacy. In addition, the pre-test and post-test questions used in the study consisted of 9 items, each of which also referred to the indicators and sub-indicators of science literacy. The correspondence between the activities in the module and the evaluation instrument shows that this module is not only relevant in content but also able to accurately measure the development of students' science literacy. Thus, the existence of augmented reality-assisted science modules is proven effective in improving students' science literacy because it is able to provide contextual, interactive, and in-depth learning experiences. In line with the opinion of Ghufroon et al. [24], which says that teaching materials can be said to be effective if they increase student abilities and student learning outcomes and improve the quality of learning.

The results of the analysis of the N-gain calculation of each science literacy indicator obtained varying results. Based on **Table 8**, the score of each science literacy indicator has increased from pretest to posttest. The indicator of identifying science issues shows an increase in the sub-indicators of recognizing issues that are scientifically investigated by 0.45 with a medium category, identifying important words to find scientific information by 0.79 with a high category, and recognizing the stages of scientific inquiry by 0.54 with a medium category. Questions on the indicator of identifying science issues ask students to identify issues or problems scientifically by utilizing their knowledge. In the pretest question, students were still unable to identify important words used to find scientific information, but in the posttest question, students were able to identify these important words by utilizing their initial knowledge. According to Van Vo and Simmie [26], the achievement of science literacy skills on the indicator of identifying science issues is seen from students' ability to recognize issues

that are scientifically investigated, identify important words to search for information, and recognize the characteristics of each key of scientific inquiry. According to cognitive learning theory, students utilize their prior knowledge to understand new information by connecting it. The level of knowledge stored in students' memory will affect their ability to recognize science issues.

The indicator of explaining phenomena scientifically in the sub-indicator of applying scientific knowledge has increased by 0.82 with a high category, interpreting phenomena by 0.45 with a medium category, and identifying explanations and hypotheses by 0.92 with a high category. This shows that the ability possessed by students is quite optimal when providing an explanation of the phenomena that are happening. For example, using their scientific knowledge to explain a phenomenon that is happening, making descriptions, or making appropriate predictive interpretations of phenomena and changes that will occur [27]. In this indicator, students are able to answer questions by applying their scientific knowledge to interpret the phenomena that occur and predict changes in these phenomena. This is in accordance with the opinion of Van Vo and Simmie [26] that students' understanding of a concept plays a role in determining their ability to explain or interpret various phenomena. Eymur and Seda [28] said that providing science phenomena to students can train their ability to analyze problems. Thus, it allows students to be more optimal in collecting data and information related to the investigations carried out.

The indicator of using scientific evidence shows an increase in the sub-indicator of identifying assumptions of 0.71 with a high category, interpreting scientific evidence and providing conclusions of 0.89 with a high category, and reflecting on the social implications of the development of science and technology of 0.86 with a high category. This shows that students are able to interpret scientific evidence and draw conclusions by interpreting the data listed in several tables and figures on the science literacy test instrument used well [26]. The indicator of using scientific evidence requires students to understand that evidence is the basis for decision-making. In other words, students must be able to show a clear and logical relationship between existing evidence and the conclusions or decisions made [29].

The effectiveness of the product developed is also determined by the student response questionnaire. The results of the analysis of student response questionnaires to the use of science modules assisted by augmented reality in each aspect obtained a percentage of 84%. Analysis of student responses in each aspect shows a good average rating. The acquisition of this good category indicates that the science module assisted by augmented reality is effective for use in learning science. Based on the assessment of students after using the augmented reality-assisted science module in the questionnaire, students find it easier to understand the problem when learning science, enjoy discussing with group members to solve problems, and through science literacy activities in the module, train them to understand more about the concepts in the respiratory system material. This is in line with the opinion of Saputra et al. [30], who said that augmented reality-based teaching modules are effective, interactive, and attractive learning media for students, especially those with visual and motor learning styles. This module utilizes augmented reality technology to facilitate understanding

of abstract concepts in subject matter through interactive 3D visualization. By using AR-based modules, students can be more in-depth in observing, analyzing, and interpreting science knowledge.

## 5. Conclusion

Based on the results of the research, the augmented reality (AR)-assisted science module developed has a positive impact on student learning, especially in improving students' science literacy. This module is not only academically valid but also practical and effective in improving students' science literacy. Its high validity, with an average percentage of 83%, indicates that this module is suitable for use in science learning in junior high school. In terms of practicality, the percentage of learning implementation of 89% shows that this module is easy to use in the teaching and learning process. Its effectiveness is proven by the N-gain score of 0.71 in the high category, as well as excellent student responses with an average of 84%, indicating that this module succeeded in improving their understanding of science concepts. This study still has limitations, such as limited-scale trials and dependence on adequate technological devices. Further research is recommended to expand the scope of trials, adapt to various learning conditions, and develop more interactive AR features to improve students' learning experience.

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