Development of Augmented Reality-Based Learning Media Using Assemblr EDU Integrated with Contextual Teaching and Learning (CTL) for the Human Respiratory System

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Abstract: The concept of the human respiratory system is abstract, making it difficult for elementary school students in the concrete operational thinking stage. Schools primarily use textbooks and conventional teaching aids, which lack interactive visual support. A questionnaire administered to 54 students revealed that 81.84% found it easier to understand the material with 3D visualization, and 90.74% were interested in learning using technology-based media. These findings highlight the need for contextual and visual learning media. This study aims to develop Augmented Reality-based learning media using the Contextual Teaching and Learnig (CTL) approach through the Assemblr EDU application; determine its feasibility through expert validation; analyze its practically through limited trials with students; and analyze teachers' responses during the dissemination phase. The research employed a Research and Development method using the 4D model, which includes Define, Design, Develop, and Disseminate stages. Data collection techniques involved interviews, expert validation questionnaires, and student and teacher response questionnaires. Validation results indicated high feasibility, with scores of 88.57% (content expert) and 82.67% (media expert). Trials with 12 students showed a practicality score of 91.67% (very interesting) and teacher responses averaged 89.14% from 50 teachers. The developed media is feasible, practical, and potentially applicable in elementary science learning.

Keywords: Assemblr EDU; Augmented Reality; Contextual Teaching and Learning (CTL); Human Respiratory System; Learning Media.

Introduction

The rapid development of science and technology demands innovation and creativity in learning. The use of information and communication technology in the digital age has become an important component in supporting the effectiveness and success of the teaching and learning process (Lahagu et al., 2024). However, the rapid development of technology also brings challenges that need to be addressed in the field of education

(Siringoringo & Alfaridzi, 2024). Therefore, educational approaches need to be adapted so that the younger generation can develop critical thinking, analytical, and problem-solving skills to address various challenges in the future.

One branch of science that plays an important role in developing students thinking skills is science. This science studies the relationships between living things and their interactions in the human environment (Kemendikbud, 2022). However, the science learning

process often faces obstacles, especially in conveying abstract concepts that are difficult for students to understand. In addition, a major challenge in education today is the weak implementation of learning by teachers in schools (Susanto, 2016). Teachers are expected to master skills and adapt to technological advancements and global challenges (Lase, 2019). Therefore, educational institutions need to prepare new orientations and literacy to support learning transformation.

The integration of technology in teaching requires teachers to continuously improve their digital literacy and adapt their teaching methods in order to utilize new tools effectively (Song & Park, 2018). Educational technology enables teachers to tailor learning materials to the needs of learners, support instructional differentiation, and improve the quality of learning (Sibayan et al., 2019). In this context, the learning process is not merely a transfer of knowledge, but also an interaction aimed at improving students' knowledge, skills, and attitudes.

According to Gagne, the ideal learning process should be able to elicit learning events and cognitive activities in students (Warsita, 2018), supported by appropriate learning media (Kustandi & Dermawan, 2020). However, the media available at the elementary school level are generally still limited to textbooks and conventional teaching aids (Wardana et al., 2022), which tend to make students only understand theoretical aspects (Allam & Wibowo, 2023), not visually and interactively. Piaget also stated that elementary school students, especially those aged 7-11 years, are in the stage of concrete thinking development (Baharuddin & Wahyuni, 2018). This condition indicates that conventional learning media do not yet meet students' needs in understanding abstract concepts.

Teachers and students also face difficulties in finding examples that are relevant to the material being taught, as well as difficulties in visualizing the material. As a result, students' understanding of the learning material becomes limited. One of the contributing factors is the minimal use of learning media (Diani & Wulandari, 2025). Learning media plays an important role in helping students understand the material and facilitating the interpretation of information more optimally. This is in line with Hamalik's (1983) opinion that learning media can stimulate students' interest and motivation to learn. This is reinforced by the research of Zhou et al. (2024), which states that interactive media has a positive impact on students' motivation and learning experiences.

The low level of active participation among students also results in learning that focuses solely on memorization, including when studying the human respiratory system (Muawana & Erman, 2023). The concept of the respiratory system includes vital processes such as organ functions and mechanisms in the human body. If these concepts are not introduced properly, misunderstandings may occur, which can have a negative impact on students' learning outcomes and their understanding of subsequent material (Anggoro et al., 2022). Utamy & Rosdiana (2023) state that the limitations of learning media that can visualize material concretely can affect students' level of understanding of terms and abstract concepts.

Diagnostic test results of 113 primary school students showed variations in the level of understanding of the concept of the human respiratory system. Based on the analysis using the two-tier diagnostic test instrument, it was found that 49.72% of learners did not understand the concept, and 4.78% had misconceptions, which were categorized as low level. This finding shows that almost half of the learners did not understand the human respiratory system material well, although misconceptions only occurred in a small number of students. The incomprehension is caused by incomplete reasoning and limited learning media used (Dewi Ratih et al., 2024).

Interviews with the Regional Coordinator and teachers revealed that although some schools already have facilities such as Chromebooks and internet access, their utilization is still low, partly due to limited time for teachers to develop learning media. On the other hand, interviews with students show that they prefer mobile phone-based media, animations, and interactive applications over lecture methods or conventional teaching materials. The questionnaire results of 54 students showed that 81.84% felt easier to understand the material with 3D visualization and 90.74% were interested in learning using technology-based media. Based on teacher responses, all respondents expressed interest in innovative media that are attractive and can improve digital skills. These findings indicate the need for the development of contextual, visual, and technology-based learning media. One learning approach that is considered relevant is Contextual Teaching and Learning (CTL).

Contextual Teaching and Learning (CTL) is a learning approach that encourages teachers to relate the material taught to real-life situations experienced by students. With this approach, students are expected to understand the relationship between the information obtained in class and its application in everyday life (Penanta et al., 2023). Students find it easier to understand material when it is presented in the context of real life and involves hands-on activities that encourage them to interact directly with the learning material (Arsyad & Palloan, 2025). The main goal of CTL

is for students to not merely memorize information, but to be able to understand, connect, and apply that knowledge in the real-life contexts they experience. CTL is rooted in constructivist theory, which emphasizes the importance of direct experience in learning.

CTL consists of seven main components, namely constructivism, inquiry, questioning, learning communities, modeling, reflection, and authentic assessment (Johnson, 2011). However, impact of the of the CTL approach in the learning process is greatly influenced by the selection of appropriate learning media. The media used must be able to support the application of CTL principles in a concrete and interesting way for students. AR simulations allow students to investigate and analyze directly, in line with CTL principles. The use of AR with applications such as Assemblr EDU supports CTL principles by enabling students to reflect through direct interaction and observation, as well as allowing students to learn independently. This use of AR facilitates constructivist-based learning, where students build their own understanding through experience and exploration. With AR, students can explore concepts of the respiratory system in real-world contexts, providing a deep and contextual learning experience.

Augmented reality technology is a potential solution in education because it is able to incorporate virtual objects into the real world directly. Learners can visualize and explore learning objects from various points of view interactively and in real-time through digital devices (Safira et al., 2022). AR technology also helps overcome difficulties in understanding abstract concepts, such as the structure and mechanism of the human respiratory system, through concrete and easy-to-understand visual representations. AR has proven to be effective in visualizing complex science concepts that are not directly visible, such as the mechanism of inspiration and expiration, because it is able to display three-dimensional objects in a real context in real-time (Rahmadhani & Kurnia, 2024). This shows that Augmented Reality-assisted materials can be an innovative solution in supporting technology-based learning processes (Hermayanti & Setyasto, 2025).

One of the platforms that can be utilized to develop AR-based learning media is Assemblr EDU. This platform combines 3D models with digital elements such as animations, videos, and quizzes, thus providing a holistic learning experience and supporting various learning styles (Maricic et al., 2024). Assemblr EDU can be accessed through smartphones, tablets, Chromebooks, and other devices that support AR technology. This accessibility makes it easier for learners to interact with the learning content thus increasing learner engagement (Pasande & Hakim, 2025).

Research conducted by Rahayu & Wulandari (2024) shows that Augmented Reality-based media is effective in learning the respiratory system. However, the media has not been equipped with interactive features such as quizzes, and has not been explicitly linked to the achievements in the Merdeka Curriculum. Research by Umam et al. (2024) developed AR-based human respiratory system learning media using the 4D development model. The results show that the media developed are valid and receive positive responses from teachers and students. However, this research has not integrated certain learning approaches such as Contextual Teaching and Learning (CTL), so the focus is only on the visualization aspect without emphasizing the connection of the material to the real-life context of students.

Research conducted by Multidisipliner et al. (2024) shows that interactive multimedia based on the CTL approach to human respiratory system material is valid, practical, and effective in improving students' understanding. However, the media developed is still in the form of modules and educational games without the integration of Augmented Reality technology, so it has not been able to visualize the breathing process concretely in the form of three-dimensional objects that can be accessed and scanned in real-time via mobile devices. Meanwhile, Allam & Wibowo (2023) developed AR learning media for the introduction of the human respiratory organ system using markerless technology. Although innovative, these studies did not use learning platforms such as Assemblr EDU and did not apply the CTL approach, so they have not encouraged active involvement of learners in critical and reflective thinking processes.

Thus, there is still a gap in the development of learning media that integrates the CTL approach and AR technology based on the Assemblr EDU platform, especially on human respiratory system material. Therefore, this study aims to develop Contextual Teaching and Learning (CTL)-based Augmented Reality learning media using the Assemblr EDU application on human respiratory system material; determine the feasibility of media through validation by material experts and media experts; analyze the practicality of media through limited trials with grade V students; determine teacher responses to media at the dissemination stage.

Method

This study uses the Research and Development (R&D) method with the aim producing and testing the feasibility of a learning product. According to Borg and Gall in Sugiyono (2019), R&D is a structured and

systematic process of designing, evaluating, and refining a product so that it can be used effectively. The development model applied in this study is the 4D model, namely Define, Design, Develop, Disseminate, which was developed by Thiagarajan et al. (1974). This model was chosen because it is considered appropriate for developing systematic and gradual learning tools. The stages of the 4-D development model used in this study can be seen in the Figure 1.
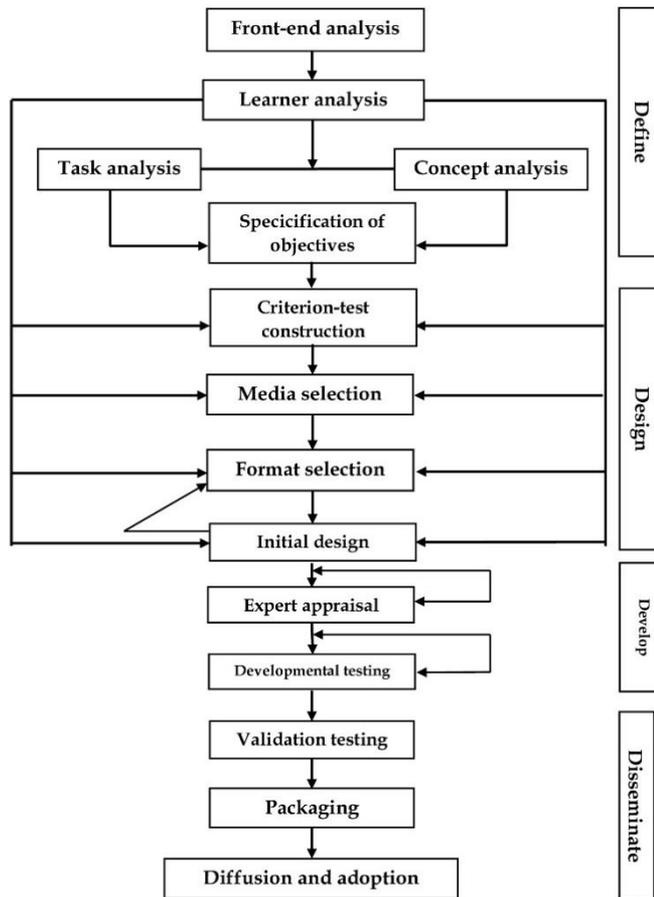

Figure 1. 4-D Development Stages
Source: (Trianto, 2011)

Based on these stages, the subjects in this study involved 54 students and 4 teachers from four elementary schools in the define or needs analysis stage, 2 expert lecturers as media validators, 12 fifth-grade students in the limited trial stage, and 50 teachers as respondents in the dissemination stage. The subjects in this study were selected purposively, considering their relevance to the objectives and stages of the process of developing Augmented Reality-based learning media and the Contextual Teaching and Learning approach.

Data collection was conducted through interviews, expert validation questionnaires, and student and teacher response questionnaires. Interviews were conducted with regional coordinators, school principals,

teachers, and fifth-grade students to obtain data on needs and understand the context of learning media use in the classroom. Questionnaires were used to obatain data from expert validators, teachers, and students on the learning media developed. The questionnaire format was varied based on the type of respondent. A five-point rating scale (Likert scale) was used for validators and teachers, while the Guttman scale (with Yes/No answers) was used to measure students responses to the tested media.

The collected data were analyzed using descriptive qualitative and quantitative approaches. Quantitative data analysis was performed by calculating percentages, and the results were classified based on predetermined interpretive criteria. Meanwhile, qualitative data, which included interview results and input and responses from validators, were analyzed descriptively through three stages: data reduction, data presentation, and conclusion drawing. The rating scale used in the questionnaire is shown in the following table as a reference for quantitative data processing:

Table 1. Likert Scale

Quantitative Analysis	Score
Very good	5
Good	4
Good enough	3
Not good	2
Not very good	1

Source: Sugiyono (2019)

The average rating given by media experts and subject matter expert is calculated using the following formula:

$$\bar{x} = \frac{\sum xi}{n} \tag{1}$$

Description:
$\bar{x}$ = Average value
$\sum xi$ = Total sum of each data point
n = Number of data points

After obtaining the average score for each aspect, the next step is to calculate the percentage of the total score to determine the overall suitability of the media. The percentage is calculated using the following formula:

$$P = \frac{\text{Total Answer of Questionnaire}}{\text{N X Highest Weight x Total Respondent}} \text{ X } 100 \tag{2}$$

Were:
P = The Percentage of assessment
N = Total Item of Questionnaire
Source: Sambodo et al. (2019)

The percentage results are then interpreted based on the eligibility criteria presented in the Table 2.

Table 2. Feasibility Interpretation Criteria Table

Percentage (%)	Criteria
81-100	Very Feasible
61-80	Feasible
41-60	Decent Enough
21-40	Not Feasible
0-20	Very Inappropriate

Source: de Moraes et al. (2023)

The questionnaire for students used the Guttman scale, which is suitable for elementary school students because it only consist of two answer choices, "Yes" and 'No", as shown in the following table:

Table 3. Guttman Scale

Answer	Value or Score
Yes	1
No	0

Source: Riduwan (2010)

Student responses were analyzed using the percentage of each indicator using the Formula 3.

$$P = \frac{Total\ score\ obtained\ in\ 1\ item}{Ideal\ score\ in\ item}\ X\ 100 \qquad (3)$$

To calculate the final results of the student response questionnaire using the Formula 4.

$$P = \frac{Percentage}{Maximum\ score}\ X\ 100 \qquad (4)$$

Description:
P = Percentage
Maximum score = Highest score for each item x number of items x number of respondents

After knowing the results of student responses then the data is referred to the Table 4.

Table 4. Student Response Analysis Criteria

Percentage (%)	Criteria
81-100	Very Interesting
61-80	Interesting
41-60	Quite Interesting
21-40	Not Interesting
0-20	Very Unattractibe

Source: Riduwan (2010)

Teachers responses to the learning media were analyzed using a Likert scale and calculated using the same average and percentage formulas as in the expert validation. The results of these calculations were then interpreted based on the Table 5.

Table 5. Teacher Response Interpretation Criteria

Percentage (%)	Criteria
81-100	Very good
61-80	Good
41-60	Good enough
21-40	Not good
0-20	Not very good

Qualitative data in this study were collected through interviews and open-ended questions from questionnaires. The analysis process was conducted using a descriptive approach through three main steps. The purpose of this analysis was to obtain in-depth information useful for further developing Augmented Reality-based learning media desigmed using the Contextual Teaching and Learning (CTL) approach through the Assemblr EDU application.

Result and Discussion

Result

This study has developed an Augmented Reality-based learning media with a Contextual Teaching and Learning (CTL) approach using the Assemblr EDU application, which focuses on human respiratory system material. The results of this media development process refer to the 4-D model stages:

Define Stage

The define stage began with an initial analysis through interviews with teachers and fifth-grade students at SD Negeri 2 Tamansari. The interview results showed that IPAS learning was still dominated by lectures, which were ineffective in conveying abstract concepts such as the respiratory mechanism. The media used so far, such as pictures and videos, were considered suboptimal, and teachers experienced time and energy constraints in preparing interesting and effective learning media.

Interviews with the regional coordinator revealed that schools in the Karanglewas sub-district already have supporting devices such as Chromebooks and projectors. Some media development training, such as the use of Canva, has been provided to teachers. However, teachers skills in developing technology-based media are still limited, and there has been no specific training related to Augmented Reality media. The Regional Coordinator stated that AR has the potential to be an innovative learning tool in elementary schools. Additionally, a needs assessment survey was distributed to teachers at four elementary schools. The results of the teacher needs assessment survey are summarized in the Table 6.

Table 6. Results of the Teacher Needs Survey

Statement	Percentage %
I believe the human respiratory system material is quite abstract for students.	80
I find it difficult to explain the human respiratory system concretely to students.	85
I do not yet have appropriate learning media to explain the human respiratory organs.	85
I need learning media that can help visualize body organs more realistically.	90
I need engaging and interactive media to make students more interested in learning science.	95
Technological devices (gadgets, projectors, or internet) are available in my school to support learning media.	95
I have not yet optimally utilized those technological devices in learning.	80
I want to improve my ability to use interactive digital learning media.	95
I am interested in trying innovative learning media that is easily accessible and usable in teaching and learning activities.	100
Students will be more active if learning is delivered using visual and interactive media relevant to their daily lives.	100
Overall average	90.5

In the student analysis stage, researchers explored student characteristics and levels of understanding through interviews and questionnaires. Interviews revealed that students had difficulty understanding the human respiratory process and various disorders associated with it. In addition, students stated that they were more interested in learning through digital devices such as cell phones, either by watching educational videos or accessing materials through Google. To obtain more in-depth data on students conceptual understanding, the researcher also administered a two-tier diagnostic test to 113 students, which revealed that most students did not understand the basic concepts of the respiratory system, and some had misconceptions. Futhermore, a needs survey was distributed to fifth-grade students from four elementary schools. The summary of the survey results is presented in the Table 7.

Table 7. Results of Student Needs Survey

Statement	Percentage %
I do not fully understand the organs in the respiratory system.	70.37
I cannot yet explain how the human breathing mechanism works.	94.44

Statement	Percentage %
I prefer learning with pictures or animations rather than just reading a book.	72.22
I understand better when I can directly see a visual or 3D model of body organs.	81.48
I am interested in trying new technology-based learning media.	90.74
So far, I have only learned using books and a whiteboard.	64.81
My teacher has used technology-based learning media (videos, animations, apps).	81.48
I have never used Augmented Reality media at school.	100
I want science learning to be more fun and not boring.	87.04
I want to learn the respiratory system material from home using a mobile phone or laptop.	88.89
Overall average	83.15

At the task analysis stage, media design was carried out with reference to the Contextual Teaching and Learning (CTL) approach, which included student tasks such as exploring AR media, group discussions, answering reflective questions, and completing AR-based quizzes. These tasks were designed to build student engagement both individually and collaboratively.

In the concept analysis stage, there main concepts are incorporated into the AR-based media: the organs of the human respiratory system, the mechanisms of human respiration, and disorders of the human respiratory system. These three concepts area packaged through seven CTL principles consisting of Consctructivism, Inquiry, Questioning, Learning Community, Modeling, Reflection, and Real Assessment.

In the learning objective analysis stage, learning objectives are formulated to support the achievement of IPAS level V elementary school on the topic "How Breathing Helps Me Perform Daily Activities." Learning media will not be effective if not used in accordance with the content and objectives that have been designed; even the most advanced technology will not be useful if it deviates from the focus of learning (Muslim, 2020). After participating in learning using Augmented Reality media based on the Contextual Teaching and Learning approach, students are expected to be able to: Identify the structure and function of the human respiratory system through exploration in AR media; Analyze the mechanisms of the human respiratory system based on the animated simulations displayed in the AR media; Answer the teacher's questions about respiratory disorders through exploration within the AR media;

Discuss in groups to share experiences and express ideas about maintaining lung health; Demonstrate the functioning of the lungs and diaphragm in the respiratory process based on visualizations in AR media; Reflect on understanding and attitudes toward maintaining respiratory health through reflective questions displayed in AR media; and Complete an AR-based assessment to demonstrate understanding of the human respiratory system.

Design Stage

During the media selection stage, the media was presented through the Assemblr EDU application, accessible via a barcode or QR code and the Assemblr EDU link, along with learning guidelines for students and a teacher's guidebook in both printed and digital formats. During the initial design stage, the initial media design was created in the form of a flowchart and storyboard to illustrate the navigation flow and content of the media. Researchers designed flashcards equipped with QR codes and markers. These QR codes can be scanned by digital devices, providing direct access to Augmented Reality (AR)-based learning media content. Using markers, students and teachers can access interactive materials and 3D visualizations that help in understanding abstract concepts, such as the human respiratory system.
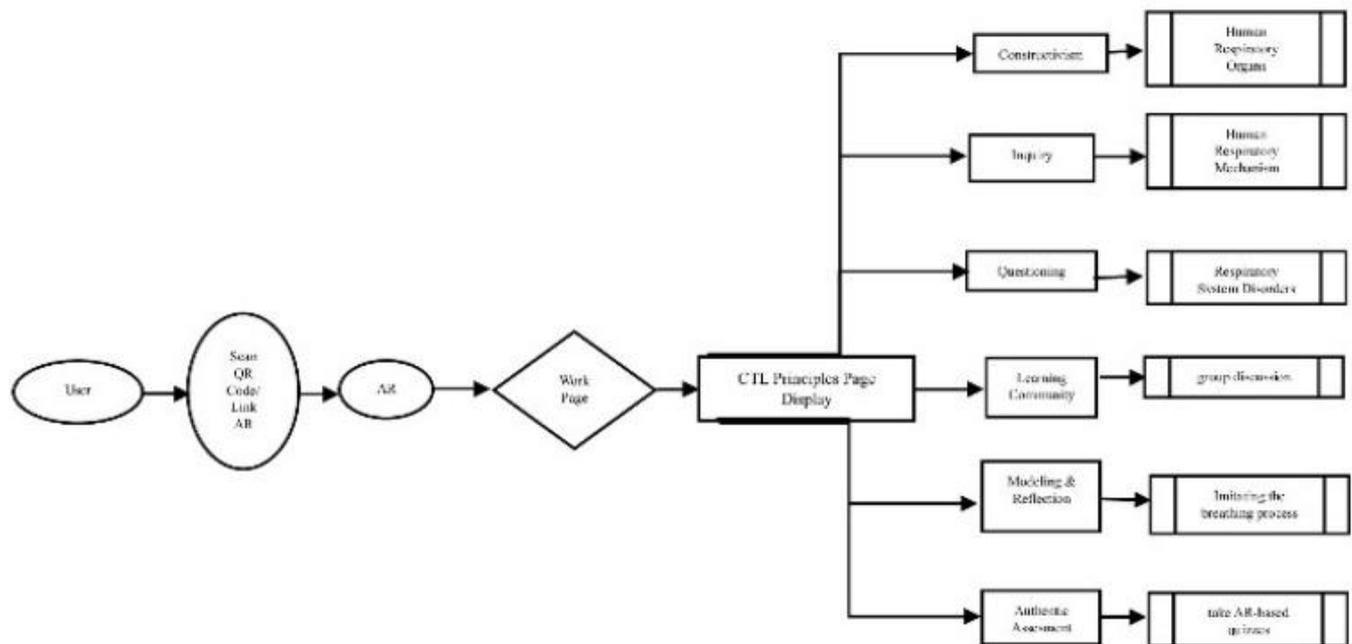

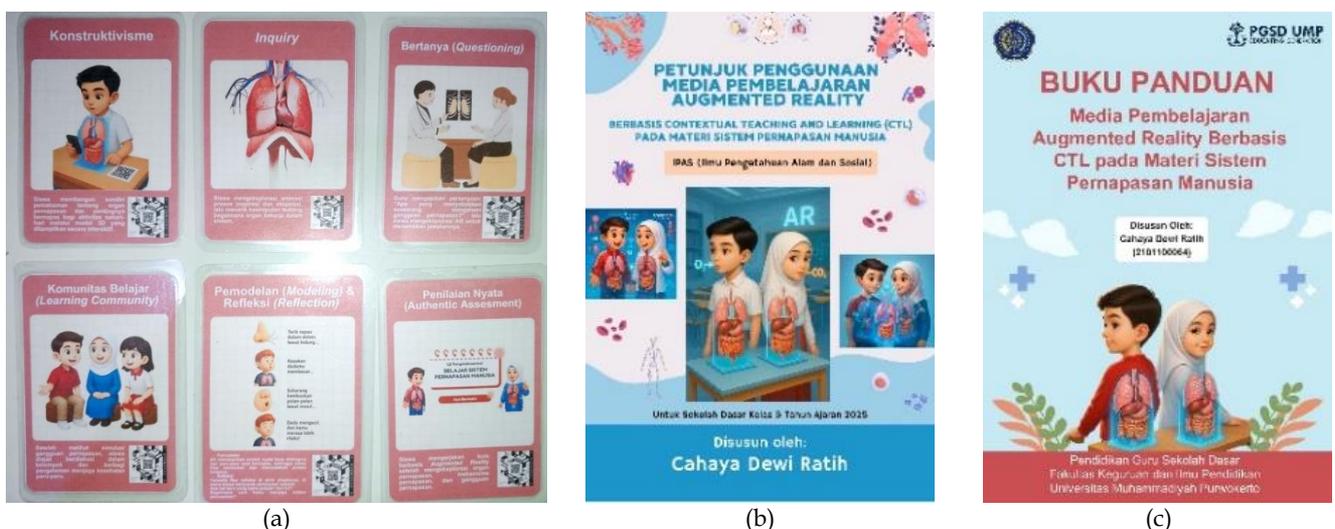**Figure 2.** Application Flowchart

(a)   (b)   (c)

Figure 2. Media developed: (a) Augmented Reality Based Flashcardse; (b) Book Cover Learning Guide; (c) Book Cover Teacher's Guide

The researchers also compiled a learning manual for students and a teacher's guidebook as supporting media. The student book contains steps for independent use of the media, while the teacher's book contains guidelines for implementing the media in classroom learning.

Development Stage

At this stage, two main activities were carried out, namely expert validation and limited-scale development trials. Material validation was carried out by an expert lecturer in the field of Natural Sciences, Badarudin, M.Pd., with a focus on the suitability of the respiratory system material content to the learning objectives that had been formulated. The results of the material validation scores obtained by experts are shown in the Table 8.

Table 8. Material Expert Validation Results

Indicators	Item Count	Score	Max Score	Average	Percentage (%)
Material Relevance	3	14	15	4.67	93.33
Material Organization	3	14	15	4.67	93.33
Evaluation/Exercises	3	12	15	4.00	80.00
Language	2	8	10	4.00	80.00
Contextual Teaching and Learning (CTL) Approach	3	14	15	4.67	93.33
Total	14	62	70	4.43	88.57
					(Very Feasible)

Based on the validation results by subject matter experts, the indicators with the highest scores include relevance of material, organization of material, and application of the CTL approach, each with an average score of 4.67 and a feasibility percentage of 93.33%. Based on the assessment results from experts, it can be concluded that the material using Augmented Reality meets the eligibility criteria in terms of material and media display. Therefore, the material is considered eligible and ready for testing (Risqiyono & Setyasto, 2025). Although the media has been declared feasible, the validation results show that there are still several aspects that need to be improved.

Subject matter experts provided the following feedback: 1) Learning objectives can be further developed 2) Evaluation should be linked to children's experiences 3) Multiple-choice questions should have a minimum of 10 items, and attention should also be given to whether the questions created can assess the achievement of learning objectives. With revisions made based on input from subject matter experts, the learning media was deemed suitable for use in the next testing phase. The researchers then validated the suitability of the media with experts competent in the field of learning technology, particularly in the development of Augmented Reality-based media, namely Tri Yuliansyah Bintaro, M.Pd. The scores obtained from the media experts for the learning media are presented in the Table 9.

Table 9. Media Expert Validation Results

Indicator	Item Count	Score	Max Score	Average	Percentage (%)
Visual Appearance	4	18	20	4.50	90
Presentation	4	16	20	4.00	80
Language	3	12	15	4.00	80
CTL Approach	4	16	20	4.00	80
Total	15	62	75	4.13	82.67
					(Very Feasible)

The validation results show that the visual display indicator obtained the highest score with an average of 4.50 and a feasibility percentage of 90%. However, media experts provided several suggestions for improvement. First, media experts suggested reevaluating the user-friendliness of the media, particularly in relation to the relatively long loading time when opening the application. This needs to be further reviewed to determine whether it is caused by network quality or the size of the visual elements used. Second, it is recommended that the media be equipped with audio elements when students successfully log into the application. Third, in each scene, it is recommended to add information emphasizing the application of the CTL principle as the primary identity of this educational media.

The learning media developed has undergone improvements in terms of appearance, technical aspects, and CTL interaction principles, so that it is considered suitable for use in the student trial phase. The

Augmented Reality learning media that has been validated and revised is then presented in its final form for trial purposes and documentation of development results. The following image shows the appearance of the media developed using the Assemblr EDU application.
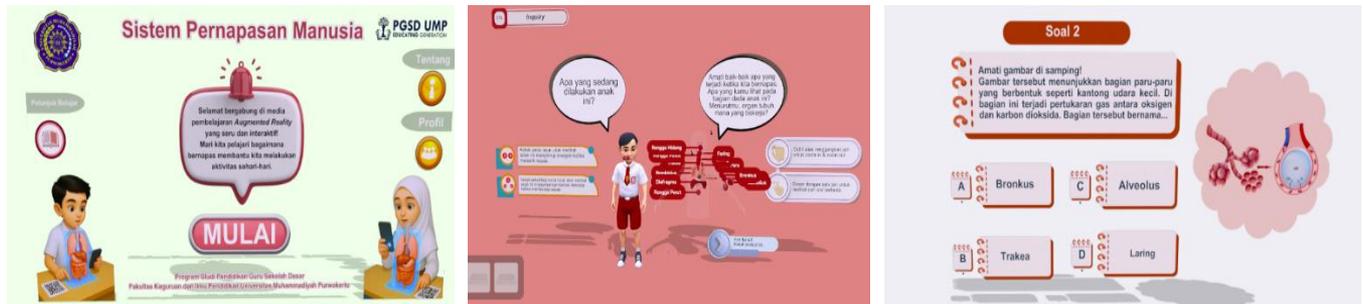

Figure 3. Learning Media Components

The development trial phase was conducted to assess students' responses to the attractiveness of the learning media. This limited trial involved 12 fifth-grade students through Contextual Teaching and Learning-based learning using Augmented Reality media through the Assemblr EDU application. The assessment results are presented in the Table 10.

Table 10. Student Trial Results

Question	"Yes"	"No"	Ideal Score	Percentage (%)
P1	12	-	12	100.00
P2	12	-	12	100.00
P3	12	-	12	100.00
P4	10	2	12	83.33
P5	10	2	12	83.33
P6	10	2	12	83.33
P7	12	-	12	100.00
P8	10	2	12	83.33
P9	11	1	12	91.67
P10	12	-	12	100.00
P11	11	1	12	91.67
P12	12	-	12	100.00
P13	9	3	12	75.00
Overall Percentage				91.67
				(Very Interesting)

Based on the results of the analysis of student responses to the CTL-based Augmented Reality learning media questionnaire, a total score of 91.67% was obtained from 13 statements. With the support of Augmented Reality, students can visualize the material in 3D form, which can deepen their understanding and motivation in learning the material (Rukmana & Setyasto, 2025). This Augmented Reality-based learning media can also make students more interested in participating in classroom learning (Arfani & Setyasto, 2025). These findings indicate that the media has a high level of appeal and is suitable for use in IPAS learning at the elementary school level.

Figure 4. Documentation of AR media trials for students

Dissemination Stage

The dissemination stage is the final stage in the 4-D development model, which aims to disseminate the developed learning media so that it can be used by a wider range of users. In this study, dissemination was carried out through validation testing activities with

teachers in three elementary schools and prospective teachers to determine the response to the media in the educational practitioner environment.

The dissemination stage was carried out to expand the reach of the developed learning media. This activity consisted of three stages: validation testing, packaging, and diffusion and adoption. In the validation testing stage, the researchers conducted direct socialization and dissemination of the media to 20 teachers from three

elementary schools, namely SD Negeri 2 Tamansari, SD Negeri 2 Pliken, and SD Negeri 1 Pliken, as well as 30 prospective teachers. After the socialization session, respondents were asked to explore the media through the Assemblr EDU link and QR code, then fill out an evaluation questionnaire. The average response per school is presented in the Table 11.

Table 11. Recapitulation of Teacher Response Results

Respondent	Total Respondents	Average Score	Persentage (%)	Category
Teachers	20	4.60	91.94	Very Good
Pre-service Teachers	30	4.31	86.33	Very Good
Total			89.14	Very Good

Based on the recapitulation results, the average response of teachers to learning media reached 90.76% in the "Very Good" category. These results indicate that the media is considered very suitable for use in learning by teachers in elementary schools. The assessment based on each aspect is shown in the Table 12.

Table 13. Recapitulation of Teacher Response Results per Aspect

Evaluation Aspect	Percentage (%)	Category
Quality and Appeal of the Media	89.60	Very Good
Ease of Use	85.40	Very Good
Curriculum Compatibility	89.70	Very Good
Language Aspect	88	Very Good
Material Presentation	89.40	Very Good
Suitability with CTL Approach	89.20	Very Good
Overall Average	88.55	Very Good

The results show that the aspect of Material Suitability with the Curriculum received the highest score, with an average of 4.48 and a percentage of 89.70%, indicating that the media content is in line with the elementary school curriculum. In the packaging stage, the main product is packaged in the form of a QR Code (barcode) in the shape of flashcards and an Assemblr EDU link that can be accessed via Android, iOS devices, or the website. This media is equipped with learning instructions for students, guiding them through the steps of use in classroom learning and independent study, as well as a guidebook for teachers. All Augmented Reality features are designed based on the principles of Contextual Teaching and Learning (CTL) to ensure integration between digital content and learning objectives.

The media was disseminated through direct socialization to teachers and prospective teachers, as well as the distribution of media links by researchers to the Head of the Purwokerto Timur Sub-District

Coordination Unit, who then forwarded them to the principal group for wider distribution. Several teachers expressed interest in using and introducing the media, although they still faced constraints such as time limitations and the need for further training. Augmented reality-assisted media developed for human respiratory system materials is an innovation in learning media that facilitates the transfer of experience and knowledge (Fauni & Isdaryanti, 2025).

Discussion

The high feasibility scores from experts and the very positive responses from teachers and students are inseparable from the media design that integrates Augmented Reality technology with the Contextual Teaching and Learning (CTL) approach. This design provides an interactive, contextual learning experience that is tailored to the characteristics of elementary school students, who are in the concrete thinking stage (Piaget dalam Baharuddin & Wahyuni, 2018). Students will be more interested and find it easier to understand the material when using innovative learning media that allows them to experience learning in a more interesting and comprehensive way, as well as helping them to visualize the concepts being studied, which supports their understanding of the material (Rahman & Setyasto, 2025).

Through AR technology, abstract objects such as respiratory organs are displayed in the form of 3D models that can be directly observed through digital devices. This visualization clarifies concepts, encourages exploration, and strengthens understanding through active student engagement. The use of augmented reality has been shown to support active engagement and conceptual understanding through immersive learning experiences (Mohamad et al., 2024). The use of learning media that combines visual and verbal elements contributes positively to a more in-depth learning process.

The CTL approach in this media also plays a role in linking the material to real-life contexts, such as reflection features, group discussions, and AR-based simulations that bring students closer to the application of concepts in everyday life. This study is limited to the validation and practicality testing phase, without measuring the effectiveness of the media on student learning outcomes. Additionally, the pilot study was conducted on a limited scale with only 12 fifth-grade students. Therefore, further research could conduct a larger-scale pilot study and assess the effectiveness of the media in enhancing conceptual understanding or learning outcomes.

Conclusion

This research produces Augmented Reality learning media based on the Contextual Teaching and Learning (CTL) approach using the Assemblr EDU application on human respiratory system material. The validation results showed that the media was declared very feasible, with a material expert validation score of 88.57% and a media expert of 82.67%. The practicality of the media based on a limited trial to 12 grade V students obtained a score of 91.67%, which was included in the very attractive category. At the dissemination stage, the media received very good responses from 50 teachers with an average percentage of 89.14%. Thus, the developed media is considered feasible, practical, and has the potential to be applied as a means of supporting science learning in elementary schools, especially on the material of the human respiratory system.

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