

Development of Augmented Reality 3D-Assisted Domino Card Worksheets to Improve Fifth-Grade Elementary School Students' Understanding of Human Respiratory Organ Concepts

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ABSTRACT	ARTICLE INFO
<i>This study was motivated by the low level of conceptual understanding among fifth-grade students at SDN Sukaharja 01 regarding human respiratory organs, stemming from the dominance of lecture-based teaching, limited use of digital technology, and the absence of a Student Worksheet (LKPD) capable of fostering active and collaborative student engagement. This study aimed to develop, assess the feasibility of, and analyze the effectiveness of an LKPD in the form of 3D Augmented Reality (AR)-assisted domino cards to improve students' conceptual understanding. The study employed a Research and Development (R&D) approach using the ADDIE model, involving 35 students from class V-A at SDN Sukaharja 01, Cijeruk District, Bogor Regency. Data were collected through observations, interviews, expert validation questionnaires, teacher and student response questionnaires, and pretest-posttest instruments, which were then analyzed using Likert scales, Guttman scales, and N-Gain calculations. The results indicate that the product was rated as highly feasible based on assessments from subject matter experts (91.22%), media experts (97.34%), and language experts (96.66%). The product proved effective, evidenced by an increase in the average score from 70 to 92, an N-Gain of 0.76 ("High" category), an N-Gain percentage of 75.90% ("Effective" category), and positive responses from students (94.09%) and teachers (86.00%), both falling into the "Very Good" category. Thus, the 3D AR-assisted domino card LKPD is proven to be valid, feasible, and effective as a learning medium for the topic of human respiratory organs in fifth-grade elementary school.</i> © 2026 Jurnal Pedagogik Pendidikan Dasar 	Article History: Submitted/Received 30 Juni 2026 First Revised 12 Aug 2026 Accepted 31 Aug 2026 First Available online 07 Sep 2026 Publication Date 31 Nov 2026 Keyword: Domino Card Worksheet (LKPD); Augmented Reality; Conceptual Understanding; Human Respiratory Organs.

1. INTRODUCTION

Natural and Social Sciences (IPAS) is a subject resulting from the integration of Natural Sciences (IPA) and Social Sciences (IPS) as applied under the Merdeka Curriculum at the elementary school level. IPAS instruction aims to foster students' curiosity about natural and social phenomena in their surrounding environment while gradually training critical thinking and scientific skills (Azzahra et al., 2023). One IPAS topic that requires deep conceptual understanding is the human respiratory organs, since students are required to understand the shape, location, and function of each organ in an integrated manner. Students' difficulty in relating the structure and function of respiratory organs is influenced by internal factors such as learning motivation and interest, as well as external factors such as insufficiently varied teaching methods and the absence of concrete media (Haliza & Dwi, 2025).

This condition was confirmed by the results of observations and interviews conducted at SDN Sukaharja 01, Cijeruk District, Bogor Regency, on 12 November 2025. Of the 35 students in class V-A, only 6 students (15%) actively participated in IPAS lessons, 22 students (55%) had not reached the Minimum Completeness Criteria (KKM), while only 18 students (45%) achieved mastery. Instruction remained dominated by lecture-based teaching with textbooks as the sole learning resource, had not utilized digital technology, and the LKPD used was still conventional, consisting of printed worksheets without activities that fostered collaborative student engagement. This condition underscored the need for a more interactive, contextual, and digitally-based learning media innovation.

One alternative relevant to the characteristics of elementary school students is an educational game medium in the form of domino cards combined with *Augmented Reality* (AR) technology. Activities of matching, arranging, and discussing the cards encourage students to think, interact, and collaborate, while three-dimensional visualization through AR helps concretize the abstract concept of respiratory organs. A number of prior studies support the relevance of developing this medium. Dewi Santika, (2025) developed a domino card medium to improve conceptual understanding of science, with highly feasible validation results and an N-Gain of 0.65 (moderate category). Nurhamidah, (2025) developed domino cards based on *Education for Sustainable Development* and obtained a perfect validation score from all experts. Febriani & Suratmi, (2025) developed a 3D *Augmented Reality* medium on the topic of the human digestive system, while (Handoko et al., 2024) concluded that AR media significantly improved conceptual understanding of IPAS in elementary schools. International systematic reviews further confirm that integrating AR into science instruction consistently improves student achievement, satisfaction, and interest (Abdullah et al., 2022; Hidayat & Wardat, 2024). Based on these results, the development of an LKPD in the form of domino cards assisted by *Augmented Reality* 3D on the topic of human respiratory organs is considered an innovation with a strong empirical foundation that has not previously been developed specifically in this context.

Based on the description above, this study aims to: (1) describe the process of developing an LKPD in the form of domino cards assisted by *Augmented Reality* 3D on the topic of human respiratory organs for fifth-grade elementary school students; (2) determine the level of validity and feasibility of the LKPD developed; and (3) analyze the effectiveness of using the LKPD in improving fifth-grade elementary school students' conceptual understanding of human respiratory organs.

2. RESEARCH METHODOLOGY

2.1 Research Design

This study uses a *Research and Development* (R&D) approach with the ADDIE model, consisting of five stages: *Analysis* (analysis), *Design* (design), *Development* (development), *Implementation* (implementation), and *Evaluation* (evaluation). The ADDIE model was chosen for its systematic and flexible nature, supporting a structured process from design through evaluation of the learning product (Maydiantoro, 2020)

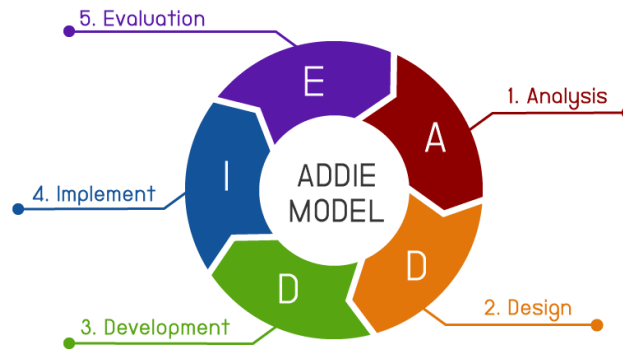


Figure 1. Stages of the ADDIE Model (Maydiantoro, 2020)

The study began with preliminary research consisting of observations and interviews to identify learning needs. The results of the needs analysis formed the basis for designing the AR 3D-assisted domino card LKPD, which was then validated by four expert validators (content, media, and language). The product, revised based on validators' recommendations, was subsequently implemented with students, with the final stage consisting of an evaluation of the product's practicality and effectiveness.

2.2 Research Subjects and Location

The research subjects consisted of two groups: four expert validators (one subject matter expert from a lecturer, one practitioner subject matter expert from a classroom teacher, one media expert, and one language expert), and product users comprising 35 students from class V-A and one classroom teacher. The technique for selecting student subjects used total sampling (sampling jenuh), in which the entire population of class V-A was made the research subject without partial sampling, given the relatively small population size and in line with the research need to obtain comprehensive response data from a single class whose problems had already been identified during the needs analysis stage. The study was conducted at SDN Sukaharja 01, located in Cijeruk District, Bogor Regency, West Java, based on the consideration that instruction at the school was still monotonous and had not optimally utilized digital technology.

2.3 Data Analysis Technique

Data were collected through observation sheets, interview sheets, expert validation sheets, teacher and student response questionnaires, and pretest-posttest questions. The validity and practicality of the product were calculated using the percentage formula $P = (\sum x / \sum x_1) \times 100\%$, with $\sum x$ as the total score obtained and $\sum x_1$ as the maximum possible score (Saski, 2021). Expert assessment used a five-point Likert scale (Rabhani et al., 2020) while the student response questionnaire used a Guttman scale with two answer alternatives, yes and no.

(Mandasari et al., 2020) The resulting percentages were then categorized into five criteria: 0%–20% highly infeasible, 21%–40% infeasible, 41%–60% moderately feasible, 61%–80% feasible, and 81%–100% highly feasible.

The effectiveness of the product on students' conceptual understanding was analyzed by comparing pretest and posttest scores using the N-Gain formula = (posttest score – pretest score) / (maximum score – pretest score) (Abdul Wahab & Azhar, 2021). N-Gain values were categorized as high ($g > 0.7$), moderate ($0.3–0.7$), low ($g < 0.3$), and failed ($g < 0$). When converted into percentages, the effectiveness interpretation criteria were divided into effective ($>76\%$), moderately effective ($56\%–75\%$), less effective ($40\%–55\%$), and ineffective ($<40\%$). The significance of the pretest-posttest score increase was then tested inferentially. A Shapiro-Wilk normality test on the difference scores indicated a non-normal distribution ($p = 0.036 < 0.05$), so significance testing was conducted using the non-parametric Wilcoxon Signed-Rank Test.

3. RESULTS AND DISCUSSION

3.1 Analysis Stage

The results of the needs analysis showed that of the 35 students in class V-A, only 6 students were active in IPAS lessons, while 55% of students had not reached the KKM on the topic of human respiratory organs. Teachers stated that instruction remained lecture-centered, learning media consisted only of textbooks and the whiteboard, and the LKPD used had not fostered collaborative student engagement. Curriculum analysis showed that instruction referred to the Merdeka Curriculum with a *deep learning* approach emphasizing *mindful learning*, *meaningful learning*, and *joyful learning*, but these three elements had not been optimally implemented due to the dominance of lecture-based teaching. This finding formed the basis for developing the AR 3D-assisted domino card LKPD, which is aligned with the Phase C Learning Outcomes (CP) of the Merdeka Curriculum on the topic of the human respiratory system.

3.2 Design Stage

The LKPD was designed to contain 15 questions and answers in the form of domino cards played in groups, covering three main topics: introduction to human respiratory organs and their functions, the mechanism of inspiration and expiration, and how to maintain respiratory organ health. Each card is equipped with a QR-code marker that can be scanned using 3D AR technology to display a three-dimensional visualization of the human respiratory organs, allowing the abstract concept to be understood more concretely by students.

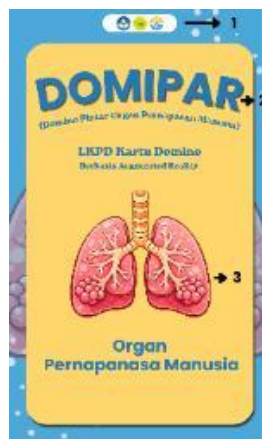


Figure 2. Design of the Augmented Reality 3D-Assisted Domino Card



Figure 3. 3D Augmented Reality Visualization of Human Respiratory Organs

3.3 Development Stage

The designed product was validated by four expert validators consisting of two subject matter experts (a lecturer and a practitioner), one media expert, and one language expert. The validation process was carried out over two rounds until the product was declared highly feasible without revision. A recapitulation of the validation results is presented in Table 1.

Table 1. Results of the Validity Test of the AR 3D-Assisted Domino Card LKPD

Validator	Validation Score	Category
Subject Matter Expert	91.22%	Highly Feasible
Media Expert	97.34%	Highly Feasible
Language Expert	96.66%	Highly Feasible
Overall Average	95.07%	Highly Feasible

Prior to implementation, an instrument trial was conducted with 34 students to measure the validity, reliability, difficulty level, and discriminating power of the test items. Of the 30 items trialed, 17 items were declared valid with a reliability coefficient of *Cronbach's Alpha* of 0.7354 (reliable criterion), 24 items were classified as easy and 6 as moderate, and 25 items had good discriminating power. These seventeen valid items were subsequently used as the pretest-posttest instrument in the study.

3.4 Implementation and Evaluation Stage

The product was implemented with 35 students of class V-A at SDN Sukaharja 01, divided into 7 groups. Practicality data were obtained from student and teacher response questionnaires after learning with the AR 3D-assisted domino card LKPD, while product effectiveness was measured through pretest and posttest scores analyzed using N-Gain. A recapitulation of the results is presented in Table 2 and Table 3.

Table 2. Results of the Practicality Test of the AR 3D-Assisted Domino Card LKPD

Aspect	Percentage	Category
Student Response	94.09%	Very Good
Teacher Response	86.00%	Very Good
Lesson Implementation	90.00%	Very Good

Table 3. Results of the Effectiveness Test of the AR 3D-Assisted Domino Card LKPD

Criteria	Pretest	Posttest
Number of Students	35	35
Highest Score	90	100
Lowest Score	50	80
Average	70	92
N-Gain	0.76 (High) / 75.90% (Effective)	

The subject matter expert validation score of 91.22% in Table 1 was obtained from the average of three raw scores, namely 88.33% and 97.33% from Subject Matter Expert 1 (a lecturer) in the first and second validation rounds, and 88% from Subject Matter Expert 2 (a practitioner/classroom teacher) in a single validation round, such that $(88.33\% + 97.33\% + 88\%) / 3 = 91.22\%$. Based on Table 1, the average scores from the subject matter, media, and language experts fell within the 81%–100% range with the “Highly Feasible” criterion, indicating that the AR 3D-assisted domino card LKPD was valid and ready for implementation. This result is consistent with the view that learning media systematically designed with content aligned to the Learning Outcomes and Learning Objectives will obtain high expert validation scores and be suitable for use in elementary school classrooms. The visual quality of *Augmented Reality* designed with high-quality visuals has also been shown to increase students' interest and learning effectiveness (Bashri et al., 2022) while the accurate use of communicative language appropriate to students' cognitive development is one of the main indicators of good LKPD quality (Armainia & Amini, 2023). This finding is consistent with studies developing AR-assisted worksheets in science instruction, which likewise showed high feasibility from expert validation results (Muttaqiin et al., 2024).

In terms of practicality (Table 2), student and teacher responses to the AR 3D-assisted domino card LKPD reached 94.09% and 86.00% respectively, both in the “Very Good” category, while lesson implementation observed by three observers reached 90.00%. The learning enjoyment aspect obtained the highest percentage on the student questionnaire (96.55%), indicating that the activity of playing domino cards while scanning 3D AR objects created an enjoyable and meaningful learning experience. The *Augmented Reality*-based LKPD, designed with a systematic learning flow, was also shown to be easily integrated by teachers into the learning process without requiring complicated procedures (Utama & Margunayasa, 2024).

The effectiveness of the product (Table 3) is shown by the increase in the average pretest score from 70 to an average posttest score of 92, with an N-Gain of 0.76 in the “High” category or 75.90% in the “Effective” category. A total of 23 students reached the “High” improvement category and 12 students the “Moderate” category. The Wilcoxon Signed-Rank Test results showed that this pretest-to-posttest score increase was statistically significant ($Z = -5.15$; $p < 0.001$), reinforcing the descriptive N-Gain finding that the AR 3D-assisted domino card LKPD effectively improved students' conceptual understanding. This improvement is closely tied to the LKPD's characteristics, which combine play-based activities, group discussion, and three-dimensional visualization through AR, synergistically creating an active, concrete, and meaningful learning experience. This is consistent with findings that *Augmented Reality* media are proven to significantly improve students' conceptual understanding, as 3D visualization transforms abstract concepts into more concrete representations (Masruroh et al., 2023), and that domino cards effectively improve conceptual understanding through the activity of matching questions and answers collaboratively (Sabari, 2023). The use of domino cards in

elementary school science instruction has also been shown to encourage students to interact actively, think systematically, and collaborate in solving conceptual problems (Istyasiwi et al., 2021). This finding reinforces international research showing that AR-based learning media effectively improves elementary school students' critical thinking skills (Zuniari et al., 2022). Overall, these results reinforce that the integration of a collaborative domino card game with *Augmented Reality* 3D technology successfully addresses the problem of students' low conceptual understanding of human respiratory organs. The significant improvement in students' conceptual understanding also reflects the product's success in encouraging students to move beyond rote memorization, consistent with the use of game-based technology as a meaningful and contextual learning medium in line with the Merdeka Curriculum (Novanto et al., 2021).

4. CONCLUSION

Based on the results of the research and discussion, it can be concluded that: (1) the process of developing an LKPD in the form of domino cards assisted by *Augmented Reality* 3D was carried out through five stages of the ADDIE model, namely *Analysis*, Design, Development, *Implementation*, and *Evaluation*, resulting in a product containing 15 questions and answers covering three main topics on human respiratory organs; (2) the LKPD developed was declared highly feasible based on validation by subject matter experts (91.22%), media experts (97.34%), and language experts (96.66%), all falling into the "Highly Feasible" category; and (3) the LKPD proved effective in improving conceptual understanding of human respiratory organs, evidenced by an increase in the average score from 70 to 92, an N-Gain of 0.76 ("High" category) or 75.90% ("Effective" category), supported by student responses of 94.09% and teacher responses of 86.00%, both in the "Very Good" category. Thus, the domino card LKPD assisted by *Augmented Reality* 3D is a viable alternative contextual learning medium for the topic of human respiratory organs in elementary school.

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