



Development of modified domino card teaching aids on the subject of earth structure and its development to improve learning outcomes of students in junior high school

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Abstract

The limited availability of interactive and effective teaching aids in science education, particularly for abstract topics such as the structure of the Earth and its development, remains a challenge at the junior high school level. Existing learning media often fail to actively engage students and to support optimal conceptual understanding, resulting in low learning outcomes. Although game-based learning media such as domino cards have been shown to enhance student engagement, their systematic development and validation as teaching aids for Earth structure material remain limited. This study aims to develop and evaluate the feasibility of modified domino card teaching aids in terms of validity, practicality, and effectiveness in improving student learning outcomes. The study employed the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development model with a one-group pretest–posttest design. The validity of the teaching aids was assessed by five experts, consisting of three lecturers and two educators. Limited trials involving 10 students were conducted to measure practicality and effectiveness. The results showed that the modified domino card teaching aids achieved a validity score of 0.80 (very valid), a practicality score of 0.92 (very practical), and an average N-gain of 0.91 (high). These findings indicate that the developed teaching aids are valid, practical, and effective for improving junior high school students' learning outcomes.

Keyword: teaching aids; modified domino cards; earth structure; development research

Abstrak. Keterbatasan alat peraga yang interaktif dan efektif dalam pembelajaran IPA, khususnya pada materi yang bersifat abstrak seperti struktur bumi dan perkembangannya, masih menjadi tantangan di tingkat sekolah menengah pertama. Media pembelajaran yang tersedia umumnya belum mampu melibatkan peserta didik secara aktif serta mendukung pemahaman konsep secara optimal, sehingga berdampak pada rendahnya hasil belajar. Meskipun media pembelajaran berbasis permainan seperti kartu domino terbukti meningkatkan keterlibatan siswa, pengembangannya sebagai alat peraga yang dirancang secara sistematis dan tervalidasi khusus untuk materi struktur bumi masih terbatas. Penelitian ini bertujuan untuk mengembangkan dan mengevaluasi kelayakan alat peraga kartu domino modifikasi ditinjau dari aspek validitas, kepraktisan, dan keefektifan dalam meningkatkan hasil belajar peserta didik. Penelitian ini menggunakan model pengembangan ADDIE (Analysis, Design, Development, Implementation, Evaluation) dengan desain one-group pretest–posttest. Validitas alat peraga dinilai oleh lima validator yang terdiri atas tiga dosen dan dua pendidik. Uji coba terbatas melibatkan 10 peserta didik untuk menilai kepraktisan dan keefektifan. Hasil penelitian menunjukkan bahwa alat peraga kartu domino modifikasi memiliki nilai validitas sebesar 0,80 dengan kategori sangat valid, nilai kepraktisan sebesar 0,92 dengan kategori sangat praktis, serta nilai N-gain rata-rata sebesar 0,91 dengan kategori tinggi. Temuan ini menunjukkan bahwa alat peraga kartu domino modifikasi layak digunakan sebagai media pembelajaran IPA dan efektif dalam meningkatkan hasil belajar peserta didik SMP.

INTRODUCTION

Learning media are instruments or methods employed to disseminate knowledge and facilitate the educational process. Djamarah and Zain (2013) assert that learning media elucidate instructional content, enhance student motivation, and facilitate conceptual comprehension. The produced learning media can assist teachers in the educational process, and it is anticipated that this media will enable students to comprehend and grasp integrated science more effectively (Saskia et al., 2022). This media can be visual, audio, or a combination of both, creating a more engaging learning experience. The theory of multimedia learning states that combining visual and verbal elements can improve the learning process because it helps students organize information better and facilitates deeper understanding. In addition, visual media can make abstract concepts more concrete and tangible for students, making it easier for them to understand the material being taught (Indah & Fadilah 2024). One learning medium that can increase student motivation and enthusiasm for learning (Nurhakim et al., 2024).

In science education, the use of appropriate learning media is necessary to help students understand concepts, especially abstract ones. Interactive and engaging learning media have been proven to increase student engagement and facilitate the understanding of complex scientific concepts (Mutia et al., 2023; Sund & Trowbridge, 2007). Teaching aids are one effective medium because they allow students to interact directly with learning materials through activities such as seeing, touching, and manipulating objects, making concepts more concrete and easier to understand (Anisa et al., 2025; Arsyad, 2011; Juwairiyah, 2013). In addition to conveying scientific information, interactive learning media also has the potential to instill educational values, including awareness of environmental issues such as food loss and food waste (Ningtias et al., 2025). Therefore, the development of interactive game-based teaching aids, such as modified domino cards, is important as an alternative learning medium to improve students' conceptual understanding and learning outcomes.

Limitations in teaching aids remain a problem in science education in various schools. Fitri (2021) reported that the lack of learning media made it difficult for teachers to create interesting lessons, which resulted in low student engagement. This condition is reinforced by the findings of Nastiti et al. (2024), which show that the limited availability of teaching aids has a negative impact on the quality of science education. In fact, there are currently various learning media that can be utilized, such as images, which are effective in helping students understand concepts, including the introduction of parts and types of energy sources. However, in practice, many teachers still tend to use lecture methods without the support of learning media (Zahro et al., 2024). The use of media combined with appropriate learning methods has been proven to improve student competence, strengthen learning interactions, and influence the way students process information conveyed by teachers (Rajagukguk, 2022).

The use of teaching aids in the form of domino cards offers an interesting and enjoyable approach to science learning. Arinna and Nikmaturofidah (2022) state that domino cards are effective in helping students understand scientific concepts through game activities that encourage collaboration. Domino cards used as learning media are designed to resemble regular domino cards, but contain statements at the bottom and answers at the top, accompanied by attractive visuals and tailored to students' abilities (Nirwana, 2023). Validation results show that domino card media have a very high validity rate of 95% (Santika & Kurnia, 2025). Additionally, the flashcard media assisted by domino cards was also considered very practical by teachers and students, with practicality percentages of 95% and 95.5%, respectively (Wulandari & Laili, 2025).

Numerous studies have demonstrated that including domino cards into the learning process is an effective method for enhancing the learning results of students. These studies demonstrate that domino cards have the potential to enhance the learning outcomes of students by utilizing a variety of research designs, including that a One-Group Pre- and Post-Experiment Design and the Pre- and post-test designs for a single group. It has been reported that findings of the research conducted by Nurfitriyanti and Lestari (2016), domino cards have a powerful impact on the enhancement of learning outcomes. The same research results were also obtained by Marian and Yansyah (2019), demonstrating that the use of domino cards as teaching tools resulted in a greater improvement in students' learning outcomes and a significant difference. Domino cards have a favorable impact on kids' learning motivation, as evidenced by a

significant t-test value. These results indicate that domino cards are highly effective teaching aids in improving students' learning outcomes and their learning motivation.

Domino card games can be effectively integrated with various subject materials. In geology lessons, domino cards can be used to help students understand the concepts of Earth's layer structure, tectonic plate movement, and volcanic processes. The Earth's structure consists of the crust, mantle, and core, where the dynamics of the crust and mantle enable geological activity, while the movement of the outer core plays a role in the formation of the Earth's magnetic field (Rakhmani, 2022). The use of domino cards is also applied in other subjects. Mumpuni and Supriyanto (2020) developed Indonesian vocabulary domino cards with color distinctions for each pair of synonyms and antonyms, making it easier for students to understand the meaning of words. In addition, physics domino card games on motion material are considered feasible and reliable as learning instruments, making them effective for use in the classroom learning process (Sumarni et al., 2022).

The use of teaching aids such as domino cards in learning about the structure of the Earth is very effective. Domino cards can help simplify complex concepts through interaction and collaboration among students. Through activities such as matching terms, definitions, and images, students can better understand the relationships between layers and geological processes, as well as enhance their motivation to learn. Additionally, this teaching aid supports the development of cognitive and visualisation skills, making learning more engaging and enjoyable (Hidayati & Wibowo, 2021). The above describes the importance of this study entitled 'Development of Domino Cards as Teaching Aids on Earth Structure and Its Development to Improve Learning Outcomes of Junior High School Students.' Junior high school students enjoy learning exercises that are interwoven with games since they make learning more exciting and the learning atmosphere more enjoyable.

RESEARCH METHODS

This research utilizes the research and development (R&D) methodology. Research and Development constitutes a systematic process designed to create new products or improve existing ones. Research is a subset of research and development (R&D). This study utilizes the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) to develop teaching aids in the form of domino cards for educating Grade VIII students on earth structure content. The ADDIE model provides a systematic approach for developing effective training programs with clear and measurable objectives (Branch, 2009). The research design is outlined in the Figure 1.

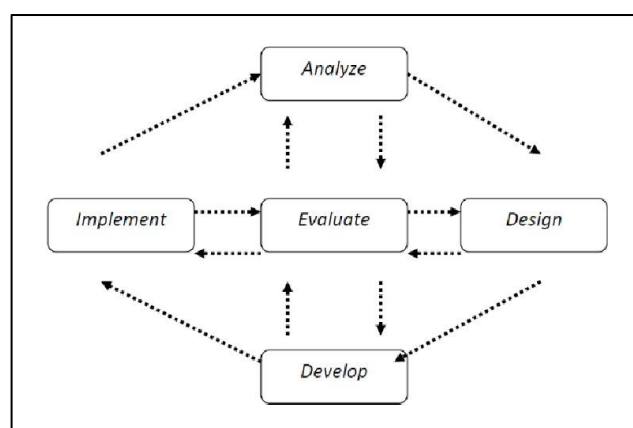


Figure 1 Research design

The target population for this investigation comprised all eighth-grade pupils at SMPN 2 Karang Bintang. The total sample size of 36 students was comprised of 10 students from class VIII A and 26 students from class VIII C, with a selection of eighth-grade students from class VIII A and all students from class VIII C. This investigation implemented purposive sampling. In this investigation, purposive sampling was implemented involved selecting all students in two different classes based on their identical learning outcomes as assessed in the mid-semester evaluation, with data obtained from the homeroom teachers.

The research was conducted at SMPN 2 Karang Bintang, located in Rejowinangun Village, RT 10 RW 05, Karang Bintang Sub-district, Tanah Bumbu Regency, South Kalimantan. The data for this study were gathered through observation, interviews, questionnaires, and assessments of learning outcomes. The assessments of learning outcomes were conducted on two occasions, specifically during the pre-test and post-test phases. The pre-test was conducted prior to the instruction of the main topic. The An initial evaluation was performed to gauge the students' baseline competencies, followed by a post-assessment completed upon the conclusion of the learning process to measure the outcomes related to the material on the human respiratory system. The assessment comprised 20 multiple-choice questions. The assessment of learning outcomes was developed in alignment with the curriculum as well as the textbooks utilized by both the teacher and the students. The following techniques were employed for data analysis:

a) Validity of the domino card teaching aid

The validity of the modified domino card teaching aids was assessed by five experts, consisting of three lecturers and two science teachers. The validation instrument covered four aspects: content feasibility, presentation feasibility, linguistic feasibility, and media suitability. The validity data were analyzed using Aiken's V formula, as recommended by Azwar (2012). The teaching aids were categorized as valid if the Aiken's V value was greater than 0.75, indicating that the media met the criteria for content and construct validity and were appropriate for use in learning activities.

b) Practicality of the domino card teaching aid

The practicality of the teaching aids was measured using a student response questionnaire administered during the limited trial and implementation stages. The questionnaire assessed three aspects: appearance, material clarity, and usefulness of the teaching aids. Practicality scores were calculated by dividing the total obtained score by the maximum possible score. The practicality criteria referred to the classification proposed by Nieveen (1999), in which a score greater than 0.80 indicates that the teaching aid is categorized as very practical and easy to use in classroom learning.

c) Effectiveness of the domino card teaching aid

The effectiveness of the modified domino card teaching aids was determined by analyzing students' learning outcomes using pretest and posttest scores. The improvement in learning outcomes was calculated using the normalized gain (N-gain) formula, which compares the increase in posttest scores relative to the maximum possible score (Hake, 1999). The effectiveness criteria were categorized as high if the N-gain value was greater than 0.70, moderate if it ranged from 0.30 to 0.70, and low if it was less than 0.30. The teaching aids were considered effective if the average N-gain score fell into the high category.

RESULTS AND DISCUSSION

This study produced modified domino cards for teaching material on the structure of the earth and its development, which have been developed and validated through simulation and classroom trials to obtain teaching aids that are the learning process might benefit from anything that is valid, practical, and effective. The modified domino cards contain core material related to the structure of the earth and its development.

In order to enhance the findings of this development research have been gathered into a product that takes the form of modified domino cards. The product is intended to improve the learning outcomes of children who are enrolled in junior high school level classes. The subtopic of the structure of the Earth and its development is the focal point of the cards inside this deck. SMP Negeri 2 Karang Bintang was the location where this research and development was carried out. The objective of this endeavor was to ascertain the validity, practicability, and effectiveness of modified domino cards. These research and development efforts were undertaken with the intention of enhancing the educational outcomes of students who had been evaluated by specialists. The data that was gathered for this purpose came in the form of validation results for the modified domino cards.

In an effort to enhance student learning outcomes at the junior high school level, this investigation also collected data in the form of student responses to the modified domino cards. which were assessed by the students through a practicality questionnaire obtained from thirty-six students. Finally, this study

obtained data on the effectiveness of using modified domino cards to improve student learning outcomes in junior high schools, which was measured through learning outcome tests by conducting pretests and posttests.

Validity of Modified Domino Card Teaching Aids

Based on research on the development of modified domino cards to improve learning outcomes, the teaching aids have a high level of validity, as shown in Table 1. The validation results from five experts indicate that the teaching aids that have been developed received several suggestions, which can be seen in Table 2.

Table 1 Expert Validation Results

No.	Indicator	V value range	Level of validity
1	Content feasibility aspects	0.77	Valid
2	Presentation feasibility	0.82	Very valid
3	Linguistic feasibility	0.81	Very valid
4	Media Effects on Learning Strategies	0.80	Very valid
Average		0.80	Very valid

Table 2 Comments and Suggestions for Validator Improvement

No.	Indicator	Comments and suggestions for improvement of teaching aids
1	Validator 1	- Delete TP number 7 in the guide. - Need to add rules related to - incorrect answers in the guide.
2	Validator II	
3	Validator III	- Clarify images - Correct answer keys - Use question marks in every teaching aid that contains questions. - Adjust sentences according to - S-P-O-K rules
4	Validator IV	- It is very good and worth implementing to motivate children to learn.

Based on the validation results using the Aiken V method, the teaching aids obtained varying levels of validity. These findings are consistent with the investigation conducted by Azwar (2012), which explains that a validity value above 0.75 indicates the instrument's suitability for use in learning. The content validity aspect obtained a score of 0.77, which is classified as fairly valid.

This indicates that although the material is in line with the curriculum, improvements are still needed based on the validators' input, as suggested in the study by Suyanto (2017). The presentation aspect received a score of 0.82, indicating that the design and layout of the media are optimal. This is in line with the findings in Munir's (2013) study on the influence of media design on the readability of material.

The linguistic aspect received a score of 0.81, indicating that the language used is communicative and appropriate for the students' level of understanding and development. This is in line with the identification in Subekti's (2019) study that the use of language in learning determines how well the learning is accepted by the students.

The aspect of media effect on learning strategies obtained a score of 0.80, which means that this media is considered to support activity-based learning strategies very well. This validity score was obtained by calculating the scores given by the validators to the items in the validation instrument. The score calculation used Aiken's formula, with the V value obtained in the calculation results for the validity of the teaching aids falling into the category of sufficiently valid (complete data in Appendix 2).

Overall, most validators assessed that the teaching aid is good and suitable for implementation, both in terms of print quality and the relevance of the content to the students' developmental level. The validity results indicate that the domino card teaching aid on the topic of Earth's structure and its development is deemed suitable and can be used as a teaching aid in science education on the topic of Earth's structure and its development.

Practicality of Domino Card Teaching Aids

The practicality of domino cards was measured using a student response questionnaire consisting of three aspects, namely appearance, material, and benefits. Ten students from class VIIIA were selected to participate in the limited testing. This class was recommended by the science teacher who taught class VIII. The students involved in this small group test were selected randomly. The small-group test aimed to determine how easy the teaching aid was to use and accept in practice. The questionnaire was filled out by the ten Grade VIII students who participated in the test, and the results are presented in Table 3.

Table 3 Results of Limited Trial Response Questionnaire on Practicality Expectations

No	Assessment aspect	Score interval	Expected practicality criteria
1	Display	0.88	Very practical
2	Materials	0.92	Very practical
3	Benefits	0.94	Very practical
Average		0.91	Very practical

The domino card teaching aids are extremely practical, as indicated by the students' responses to the questionnaire. Content received a score of 0.92, appearance received a score of 0.88, and usefulness received the maximum score of 0.94 of the three aspects that were evaluated. The aggregate average score was 0.91, which classified these teaching aids as highly practical. These results suggest that the domino cards that have been developed are user-friendly, alluring to students, and offer significant learning benefits. The teaching instruments were not revised at this time, as there were no specific suggestions from students.

The efficacy of the teaching aid was evaluated by administering a questionnaire to 26 students in Class VIII C, which was the implementation class. The results of the questionnaire responses from the 26 students are presented in the practicality calculation of the teaching aid (see Table 4).

Table 4 Results of the Practicality Calculation of the Implementation of Teaching Aids

No	Assessment aspect	Score interval	Expected practicality criteria
1	Display	0.90	Very practical
2	Materials	0.92	Very practical
3	Benefits	0.93	Very practical
Average		0.92	Very practical

Based on the practicality calculations during the implementation stage involving 26 students, it was found that the domino card teaching aids remained in the very practical category. This was evident from the average practicality score of 0.92, which showed an improvement compared to the previous limited trial, which had an average score of 0.91. In more detail, the appearance aspect scored 0.90, the material aspect scored 0.92, and the benefit aspect had the highest score, 0.93. Based on the results obtained, the modified domino card teaching aid meets the practicality criteria, making it suitable as a teaching aid to support the material on Earth's structure and its development under the 'highly practical' criteria. The practicality aspect of this teaching aid meets the success indicators in the study.

Effectiveness of Domino Card Teaching Aids

The study used a one group pretest-posttest design, in which one test class received the learning process is followed by a pre-test and a post-test, both of which consist of the same questions. These tests are

administered before and after the learning process. The findings of the domino card teaching aid effectiveness test, which were obtained from a total of twenty-six students, suggest that there was a significant increase in learning outcomes following the installation of the teaching aids. This was evidenced by the fact that the results of the test were received. The scores on the pre-test and the post-test, as well as the computation of the rise in scores from the pre-test to the post-test, which illustrates the degree to which students' performance has improved, are able to provide evidence of this. comprehension has improved as a result of the addition of the modified domino card teaching aids. In addition to this, the researcher determined the effectiveness by calculating the class mastery ratings. In the following table, Table 5, you will find the specifics of the findings about the class mastery.

Table 5 Percentage of Class Completion Before and After Using Teaching Aids

No.	Assessment aspect	Before	After
1	Incomplete (score <70)	77%	0%
2	Complete (score 70 and >70)	23%	100%

Table 6 Average N-gain Value of Students After Using Teaching Aids

N-Gain value	Category
0.91	Higher

Before the use of teaching aids, the majority of students had not achieved the passing grade, with only 6 out of 26 (20%) students obtaining pre-test scores above the passing grade or achieving a score of 70 or higher. However, after the implementation of teaching aids, there was a significant increase, with all (100%) students passing the class passing grade. The average N-gain score for all students, reflecting the degree of improvement in educational scores relative to their maximum potential, is presented in Table 6.

The results of the N-gain calculation show that the increase in students' understanding after using the modified domino cards teaching aid was in the high category, Has an N-gain value that amounts to 0.91 on average. It may be deduced from this that the instructional tool that was designed is successful in enhancing the learning outcomes of students. According to the findings that were collected, the modified domino card teaching aid satisfies the feasibility requirement, which is to successfully improve the learning results of pupils who fall into the group of having a high N-gain. According to the success indicators that were investigated in the study, this instructional tool is effective in meeting its intended purpose.

Given the popularity of this instructional tool, it is clear that the utilization of interactive and game-based learning media in educational settings is of critical importance. This strategy not only improves students' ability to comprehend concepts, but it also encourages them to take a more active role in their own education, which in turn makes the process of learning more relevant. Overall, this method is beneficial to students. The results of the research that Sawitri et al. (2024), the utilisation of interactive learning media has been demonstrated to raise the level of motivation and involvement of students in the process of learning, creating a more enjoyable and effective experience.

The use of domino cards as teaching aids was also well received by teachers and students. After three sessions, the students requested that the researcher teach longer at SMPN 2 Karang Bintang. The same is expected for other subjects that use teaching aids to make learning more student-centred. Based on these results, the domino card teaching aids developed are deemed effective in improving the educational outcomes of pupils in the high N-gain category can function as instructional resources for science lessons regarding the Earth's structure and its evolution.

CONCLUSION

Based on the results of research and development, modified domino cards for teaching about the structure of the earth and its development are deemed suitable for use in science education in junior high schools. The validity test results showed a score of 0.80, which is considered highly valid, the practicality test obtained an average score of 0.92, which is considered highly practical, and the effectiveness test showed an average N-gain score of 0.91, which is considered high. These findings indicate that game-based

teaching aids can significantly increase student engagement and learning outcomes. Scientifically, this study contributes to the development of innovative learning media that supports active and student-centered learning. The use of game-based teaching aids such as modified domino cards shows potential as an alternative learning medium to aid understanding of abstract science concepts. The results of this study are in line with the future direction of education, which emphasizes the integration of interactive media to improve the quality of the learning process and outcomes. However, this study has several limitations. These limitations include a relatively small sample size, coverage of material that is limited to the structure of the earth and its development, and a research design that does not involve a control group, so that the effects of the treatment cannot be comprehensively compared. Based on these limitations, future research should involve a larger number of students from various schools so that the results of the study have stronger generalizability. In addition, the use of an experimental design with a control group is necessary to obtain a more objective comparison of the effectiveness of the teaching aids developed. The next recommendation is to develop modified domino card teaching aids for other science subjects, especially abstract subjects, such as the solar system or geological processes. This development is expected to expand the application of game-based learning media in science education. Furthermore, follow-up research is also recommended to integrate modified domino card teaching aids with digital technology, such as application-based learning or Learning Management Systems (LMS). This integration is expected to increase the flexibility of media use and adapt learning to the demands of the digital education era.

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