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Discovery-Learning Based Handout Teaching Media Using Design-Thinking Model to Improve Students' Learning Outcomes on Earth Structure Material

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Abstract

This study aims to develop a discovery learning-based handout teaching media to improve student learning outcomes on earth structure material. The research method used was development research with Educational Design Research (EDR) design which refers to the ADDIE (Analyze, Design, Development, Implementation, and Evaluation) model with a design thinking framework. The population of this study was 32 eighth-grade students in one of the junior high schools in Bandung, using a convenient sampling technique. One class was selected, which consisted of 16 male students and 16 female students, all with an average age of 14. The class selection was based on the science teacher's recommendation. The research instrument was a validation sheet and student learning outcomes test. The data analysis technique used was the validity test of the teaching media and the effectiveness test of student learning outcomes. The results of this study indicated that the validation test data obtained a validity percentage of 93.57% in the highly valid criteria. The N-gain result of the learning effectiveness test was 0.56 in the medium category. The findings showed that using media effectively supports and improves student learning outcomes. This research makes a significant contribution to the field of education, providing clear and practical guidance for educators in creating more interesting and effective teaching media. In addition, this research also contributes to efforts to improve the quality of learning at the secondary education level, especially in the context of science learning in Indonesia.

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INTRODUCTION

The world of education constantly undergoes curriculum changes to achieve educational goals. This requires teachers to make improvements in various aspects of teaching, including the use of more innovative approaches, methods, models, or teaching materials, especially in the subject of Natural Sciences (IPA) (Misbah et al., 2022; Nurulsari et al., 2023; Ummah et al., 2021). Natural science involves a process that includes scientific behaviours and skills essential for conducting scientific inquiry and developing knowledge. It also encompasses information products such as ideas, facts, theories, concepts, and scientific laws, all considered part of scientific knowledge. In schools, science is taught according to the curriculum standards established in Indonesia (Imran et al., 2020; Khusniati & Pamelasari, 2014; Permana & Sriyati, 2021). Science is an important aspect of the independent curriculum. In addition to mastering various facts, concepts

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and principles, science also involves a discovery process in its learning (Basuki, 2023). Science learning encompasses facts, concepts, and natural phenomena, enabling students to acquire knowledge directly and within relevant contexts (Uma'iyah et al., 2023).

In the 21st century, learning has shifted towards a student-centred approach (Dichev & Dicheva, 2017; Keiler, 2018; Zakharova et al., 2022). Although there have been changes in the curriculum and regulations that have been set, problems still have not been resolved, especially in the learning process at school (Amaliyah et al., 2021). One ongoing issue in education is the lack of student motivation and difficulty understanding the material. This can lead to low student learning outcomes (Juniati & Widiana, 2017). According to Harahap & Siregar (2020) learning outcomes are one of the indicators of assessment in education. Achieving optimal learning outcomes is the main goal of the learning process. Science is one of the subjects that some junior high school students consider difficult. This can be seen from the relatively low student learning outcomes in science subjects (Amaliyah et al., 2021). Student learning outcomes in science subjects in Indonesia are still low. This can be influenced by various factors, including student characteristics, learning motivation, interest, and learning strategies (Widi & Sulistyowati, 2014). Haqiqi (2018) also revealed that the factors that cause students' difficulties in learning science are talent, interest, motivation, and intelligence. External factors of students are in the form of school facilities, teachers, infrastructure and student activities. These factors can be found through the design thinking framework.

Based on Kasri et al. (2021), design thinking involves a thought process, thinking skills, innovation, new product development, problem-solving tools, and a step-by-step guide for creating innovation. Literally, design thinking can be interpreted as a method for designing or designing one's way of thinking (Manna et al., 2022; Shen & Gao, 2020). Tim Brown first developed design thinking as a problem-solving method. It is effective because it is able to produce solutions that fit the needs (Zaki & Sukoco, 2018). Based on the design thinking framework, through distributing questionnaires and in-depth interviews in one of the junior high schools in Bandung City, it was found that teachers still use the lecture method to deliver subject matter, especially in science material. Students only listen to what the teacher explains without any variation in learning. This can cause students to be bored and less motivated to learn, and the material is difficult to understand, causing student learning outcomes to be low or decreased. Therefore, a way to overcome this is needed. What can be done by teachers is to develop media in the form of teaching materials and learning models that can encourage student motivation to learn.

Teaching materials are an important part of implementing learning in schools (Aisyah et al., 2020). Through teaching materials, teachers will find learning easier, and students will be more assisted and learn more easily (Panjaitan et al., 2022; Sianipar et al., 2022). Teaching materials can be made in various forms according to the needs and characteristics of the teaching material to be presented. One type of teaching material is handouts. Handouts are written materials prepared by the teacher to expand students' knowledge by combining information from various sources relevant to the subject matter or basic competencies and subject matter that students must master (Nurhaida, 2018). Handouts are usually written using black text and single images. Concepts are presented more clearly to attract student interest and facilitate understanding so that student learning motivation increases (Khotimah & Hastuti, 2021). The lack of teaching materials in the form of science handouts for students can be the focus of this research, and developing discovery learning-based handouts can be a distinct advantage. This handout contains brief but concise material and Learner Worksheets that encourage students to think systematically.

Discovery learning is a discovery-based learning method that has become increasingly popular in the last decade due to its student-centred learning tendency (Veermans et al., 2014). According to Hosnan (2014), discovery learning is a learning model that encourages students to learn actively by discovering and investigating on their own so that the learning outcomes are deeper and last longer in memory. Hasrah et al. (2022) also revealed that discovery learning is a learning model that can make students develop active student learning methods. The discovery learning method can create an active learning process where the teacher does not directly deliver the material or content at the beginning of the learning (Khasinah, 2021). During the learning process, students are expected to find ways to solve problems (Tampubolon, 2017). Through teaching media in the form of discovery learning-based handouts, it is hoped that it can be better in

increasing students' interest, motivation and activeness in the learning process, where students not only use interesting learning media but also experience learning methods that are not only teacher-centred but involve students directly in the learning process.

Several studies have tried to apply handouts in learning. Research showed that student learning outcomes improved after using handouts on biotechnology material (Eliyanti et al., 2019), anatomy material (Narayanan & Shankar, 2021), and microbiology (Khotimah et al., 2021). In addition, the results of research Amin & Sulistiyono (2021) showed an increase in outcomes after using handouts of 0.92 with a high category. Therefore, this research aims to develop media in the form of handout teaching materials combined with the discovery learning model to improve student learning outcomes on earth structure material. The teacher only needs to convey the material through the handout without having to repeat it again, so that the time used is more efficient. This handout is expected to help make it easier for students to understand the material. This research is different from previous studies because it develops discovery learning-based handout teaching media specifically designed for earth structure material using a design thinking framework. The novelty of this research lies in the systematic and innovative approach to the development of teaching media and the use of discovery learning methods that have not been applied in previous studies on the same material.

METHOD

The research method used was the development research with Educational Design Research (EDR) design. EDR is a design approach that focuses on research in education (Kopcha et al., 2015). The EDR research method aims to design or develop products in the field of education, such as learning models, curricula, learning media, and teaching materials to solve educational problems (Afni et al., 2021). According to McKenney & Reeves (2019), EDR is a research method that focuses on efforts to improve problems in education by producing products, whether in the form of media or other forms, that can develop actions that are designed and designed as optimally as possible to produce improvements in the field of education. Based on this explanation, EDR is suitable for developing discovery learning-based handout teaching media. EDR can provide the necessary guidance for researchers in developing products used as teaching media.

In this study, the development model used refers to the ADDIE model. The ADDIE model includes Analyze, Design, Development, Implementation, and Evaluation (Sugiyono, 2015). This ADDIE model is applied to build the main foundation in learning: the concept of developing learning product design. The ADDIE model can be applied to the design thinking framework, which focuses on human-centred aspects and has been popularized by Kelley. According to Kasri et al. (2021), design thinking is defined as a thought process, thinking skills, innovation, or new product development process, a tool for solving problems and a step-by-step guide for creating innovation. The design thinking process applied in ADDIE now consists of five principles: Empathize, Define, Ideate, Prototype, and Test & Evaluate (Gibbons, 2019). The ADDIE model with design thinking framing can be depicted in a schematic. The following schematic of the ADDIE model with a design thinking framework is shown in Figure 1.

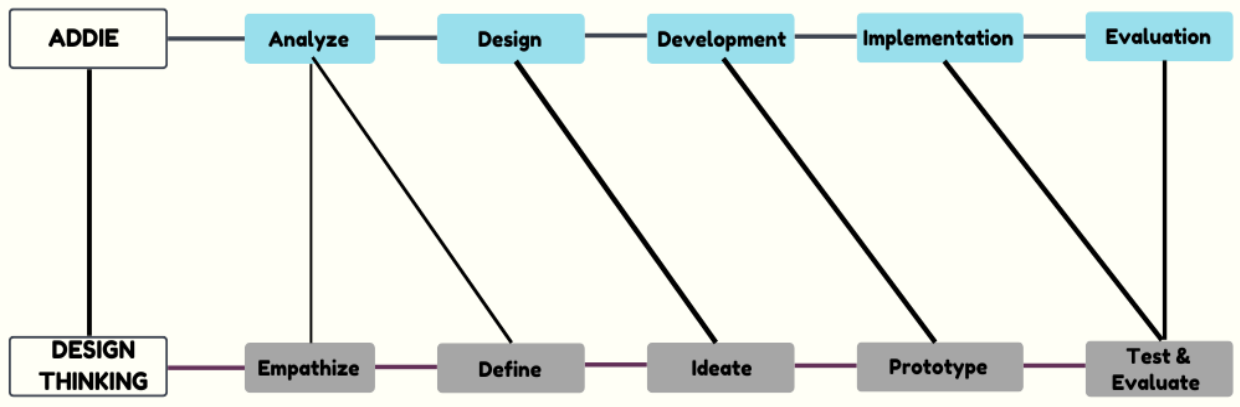


Figure 1. Schematic of ADDIE Model with Design Thinking Framework

This study was conducted in one of the public junior high schools in Bandung City, which is the school where researchers carry out field practice by applying discovery learning-based handouts on earth structure material. According to surveys, this material often makes students less active and bored to study even though this material is related to phenomena that are close to students' lives. The population of this study was the eighth-grade students in the 2023/2024 academic year selected by applying a convenient sampling technique. The sample consisted of 32 students, 16 males and 16 females, with an average age of 14 years. The class selection was based on the science teacher's recommendation.

This study used validation sheet instruments and student learning outcomes tests. The validation sheet was used to obtain data from validators regarding the suitability of language, presentation, material content, questions, and handout design. The validator fills in this sheet by checking the column that matches the statement given and is expected to provide suggestions on the validation sheet (Hasrah et al., 2022). At the same time, the student learning outcomes test is a test used to measure the extent of students' understanding of the material taught. This test consists of a pretest and posttest, each containing ten multiple-choice questions. These questions are prepared based on a grid in accordance with the learning outcomes and objectives, with the cognitive level starting from C2, namely understanding. In addition, the questions were validated by teachers and lecturers to ensure their accuracy and relevance. The pretest was given to students before using the handout, while the posttest was given after students used the handout. According to Matondang (2021), the pretest is an initial test used to analyze the extent to which students can master the material to be taught, while the posttest is the final test used to determine the extent to which students understand the material studied. The teacher can analyze whether the learning outcomes from the posttest using this handout are better than the previous test results. If student learning outcomes improve, then learning is said to be successful.

The development procedure carried out by researchers uses a design thinking framework. The five principles of design thinking carry out the following stages:

1. Empathize
   Empathize is the first stage in design thinking. This stage aims to analyze problems and needs by collecting information, such as observing the media used (Kasri et al., 2021).
2. Define
   Define is the second stage in design thinking, where all the needs obtained at the empathize stage are summarized. This stage aims to identify the core issues that will help solve the problem based on the findings from the empathize stage (Ayu & Wijaya, 2023).
3. Ideate
   Ideate is the third stage in design thinking. This stage is a design process that focuses on creating ideas. Mentally, it is the process of expanding concepts and outcomes. Ideate provides a framework for prototyping and finding innovative solutions to solve problems teachers and students face (Kelley & Brown, 2019). This stage aims to investigate and test various ideas to find the best way to solve the problem (Mahardika et al., 2022).
4. Prototype
   Prototypes are an important part of the design thinking process carried out by researchers. At this stage, researchers develop a prototype, a picture or representation of the ideas generated at the ideate stage (Ansori et al., 2023).
5. Test dan Evaluate
   The fifth or final stage in design thinking is test and evaluation. At this stage, testing is carried out. After all designs are made, an assessment is carried out to validate the design solution. The testing process involves testing the prototype by experimenting with users (Wijaya et al., 2022).

Data analysis techniques used in this research are quantitative and qualitative. Quantitative data is in numbers obtained from questionnaire validation, while qualitative data is descriptive information from validators (Hasrah et al., 2022).

Validity Analysis

The validity analysis aims to determine the assessment of the media developed, namely Discovery Learning-based handout teaching media determined by validators consisting of lecturers and teachers. To obtain validation data, researchers used a Likert Scale.

Likert Scale scoring starts from 1 to 5 with quantitative analysis of very less, less, quite good, good and very good. The data obtained was analyzed using a formula adapted from (Akbar, 2015).

$$V = \frac{Tse}{Tsh} \times 100\% \quad (1)$$

Description:
V = Validity
Tse = Total validator score
Tsh = Maximum score

From the calculation of the validity obtained in percentage, it is then interpreted based on the criteria according to Akbar (2015), as shown in Table 1.

Table 1. Conversion Level of Validity of Teaching Media

Achievement Criteria (%)	Level of Validity	Description
85 < x ≤ 100	Very Valid	Usable without repair
70 < x ≤ 85	Valid	It can be used with minor revisions
50 < x ≤ 70	Less Valid	It is not recommended for use because major revisions are needed
1 ≤ x ≤ 50	Not Valid	Should not be used

Effectiveness Analysis

Effectiveness is analyzed through the effectiveness test. This effectiveness test is based on the calculation of the data obtained to get an overview of the media developed by the researcher using the following equation:

$$\langle g \rangle = \frac{Spost - Spre}{Sm\ ideal - Spre} \quad (2)$$

Description:
<g> = Normalized gain average score
Spost = Average score of students' final test
Spre = Average score of students' initial test
Sm ideal = Ideal maximum score

The calculation results of the average N-gain obtained are then interpreted based on the criteria (Hake, 1999), as shown in Table 2.

Table 2. Interpretation of N-gain Mean Score

N-gain Average	Criteria
<g> ≥ 0,7	High
0,3 < <g> ≤ 0,7	Medium
<g> ≤ 0,3	Low

RESULTS AND DISCUSSION

This research uses a design thinking framework that is used in solving problems, as applied by Tim Brown to solve problems. This is very effective because it can produce solutions that meet user needs (Kubiak, 2024). The following stages of the research were conducted based on the five design thinking principles.

Emphasize

Empathize is the first stage in design thinking. This stage aims to analyze problems and needs by collecting information, such as observing the media used (Kasri et al., 2021). Information is collected through distributing questionnaires and in-depth interviews with students during the science learning process. Based on the results of observations and interviews, it is shown that in learning, teachers still use the lecture method to convey subject matter, especially in science material. Students only listen to what the teacher explains without any variation in learning. This can cause students to be bored and less motivated to learn. The material is difficult to understand, so it causes student learning outcomes to be low or decreased, so a way is needed to overcome this.

Define

Define is the second stage in design thinking, where all the needs obtained at the empathize stage are summarized. This stage aims to identify the core issues that will help solve the problem based on the findings from the empathize stage (Ayu & Wijaya, 2023). At the define stage, the data and information collected are used to understand the existing problems and then simplified into conclusions regarding the most pressing problems. The problems that have been selected based on the results of interviews and observations are as follows.

1) Learning, in general, still uses the lecture method
2) Lack of teacher variety in teaching
3) Students only listen to what is explained by the teacher
4) Monotonous learning style from the beginning to the end of learning
5) Less interesting learning materials
6) Lack of learning resources
7) Students have difficulty understanding the content of the material in the textbook.
8) Not using technology during learning
9) Students chat and do not pay attention to the teacher when learning
10) The classroom atmosphere is not conducive

From these problems, the researcher will extract information that can be incorporated into the creative process later.

Ideate

Ideate is the third stage in design thinking. This stage is a design process that focuses on creating ideas. Mentally, it is the process of expanding concepts and outcomes. Ideate provides a framework for prototyping and finding innovative solutions to solve problems teachers and students face (Kelley & Brown, 2019). This stage aims to investigate and test various ideas to find the best way to solve the problem (Mahardika et al., 2022). Ideate is a very interesting stage because it will generate many ideas that can eventually be selected as the best idea. At this stage, brainstorming will be used to obtain ideas as solutions to existing problems. Brainstorming is an effective method to generate diverse ideas by involving collaboration between teachers, learners and researchers who engage, listen and build on each other. It involves responses and ideas to generate solutions (Romadhoni, 2014). The problem solutions obtained can be described in Table 3.

Table 3. Problem Solution

Problem	Solution
Learning, in general, still uses the lecturing method Lack of teacher variety in teaching Students only listen to what is explained by the teacher. Monotonous learning style from the beginning to the end of learning Less interesting learning materials Lack of learning resources Students have difficulty understanding the content of the material in the textbook. ot using technology during learning	Creating interactive learning media that is interesting and easily understood by students

Problem	Solution
Students chat and do not pay attention to the teacher when learning The classroom atmosphere is not conducive	Use learning methods that can attract students to focus

The researcher's ideas in Table 3. are solutions to overcome problems in the learning process. As noted in the table above, the researcher has collected and evaluated these solutions to determine the most suitable ones to implement.

Prototype

Prototypes are an important part of the design thinking process carried out by researchers. At this stage, researchers develop a prototype, a picture or representation of the ideas generated at the ideate stage (Ansori et al., 2023). This prototype stage starts with making a design by determining the cover and title of the discovery learning-based handout by the material to be taken, namely the material of the earth's structure, then paying attention to the attractive design aspects of the discovery learning-based handout so that students can be more excited in using the discovery learning-based handout that has been developed.

Furthermore, the prototype produced at the design stage was then developed into a discovery learning-based handout. Starting from the cover, preface, content of the handout, and all other elements are carefully arranged to produce a product that meets expectations while still paying attention to the learning outcomes and objectives that students will achieve. The cover of the discovery learning-based handout can be seen in Figure 2 below.

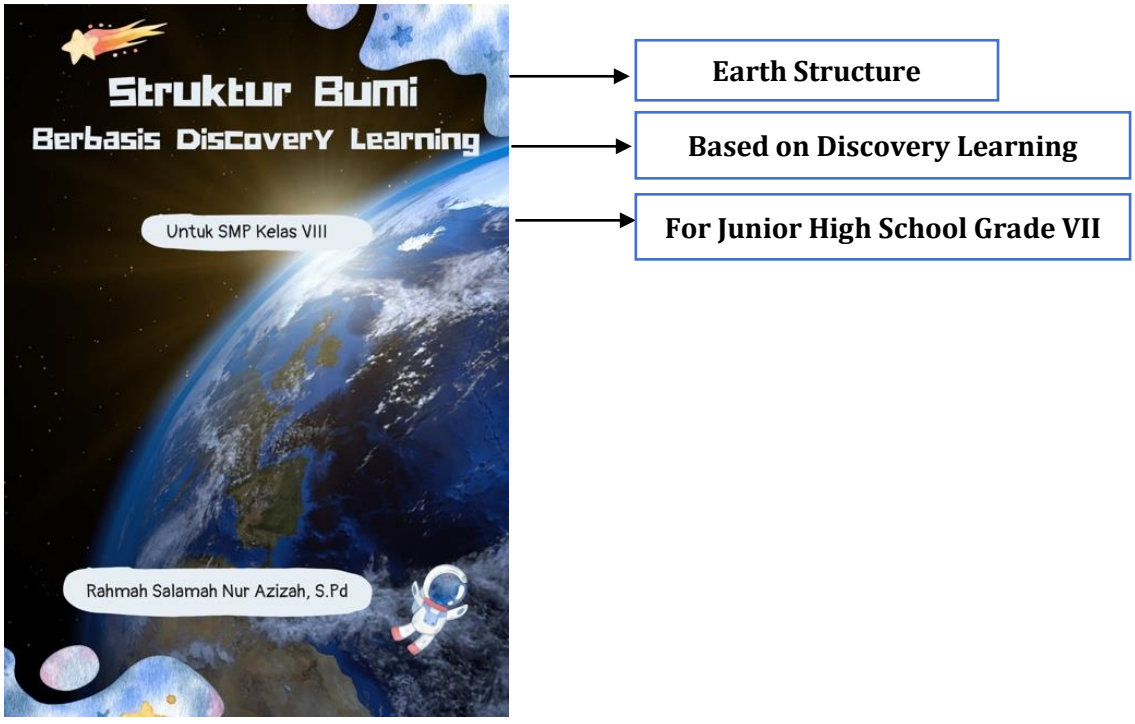
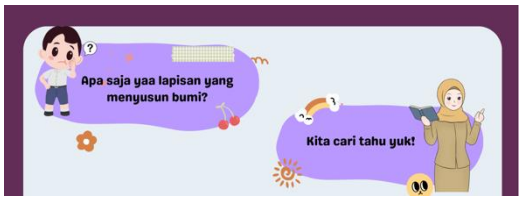


Figure 2. The Cover of Discovery Learning-Based Handout

The design of the Discovery Learning-based handout can be seen in Figure 3.

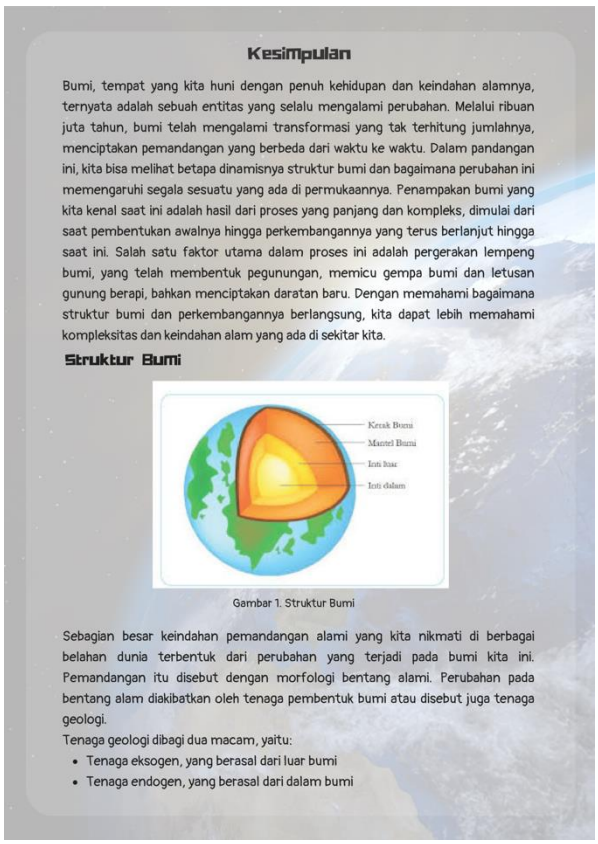
(a)



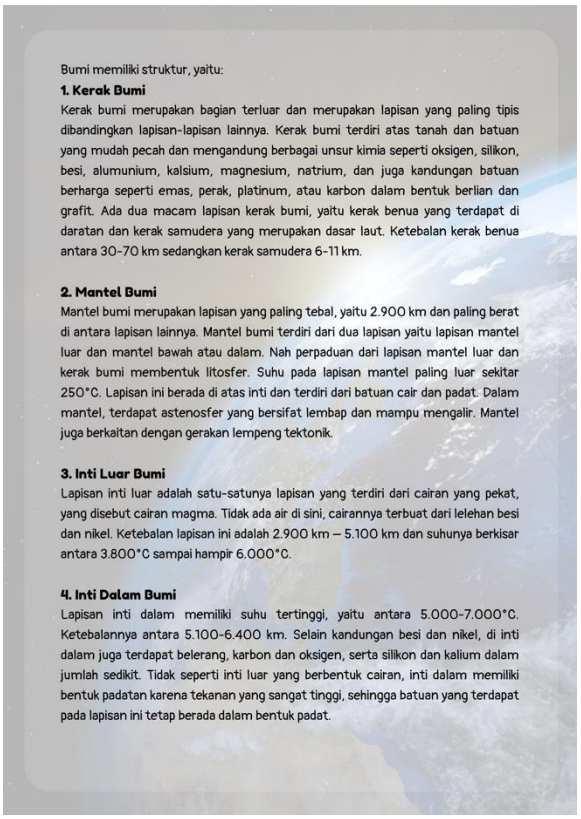
(b)

(c)

(d)



(e)



(f)

Figure 3. Discovery Learning-based Handout Design: (a) Stimulation; (b) Problem Statement; (c) Data Collection; (d) Data Processing; (e) Verification; (f) Generalization

The final form of the discovery learning-based handout prototype can be seen in Figure 4 below.

igure 4.a. Discovery Learning-based Handout

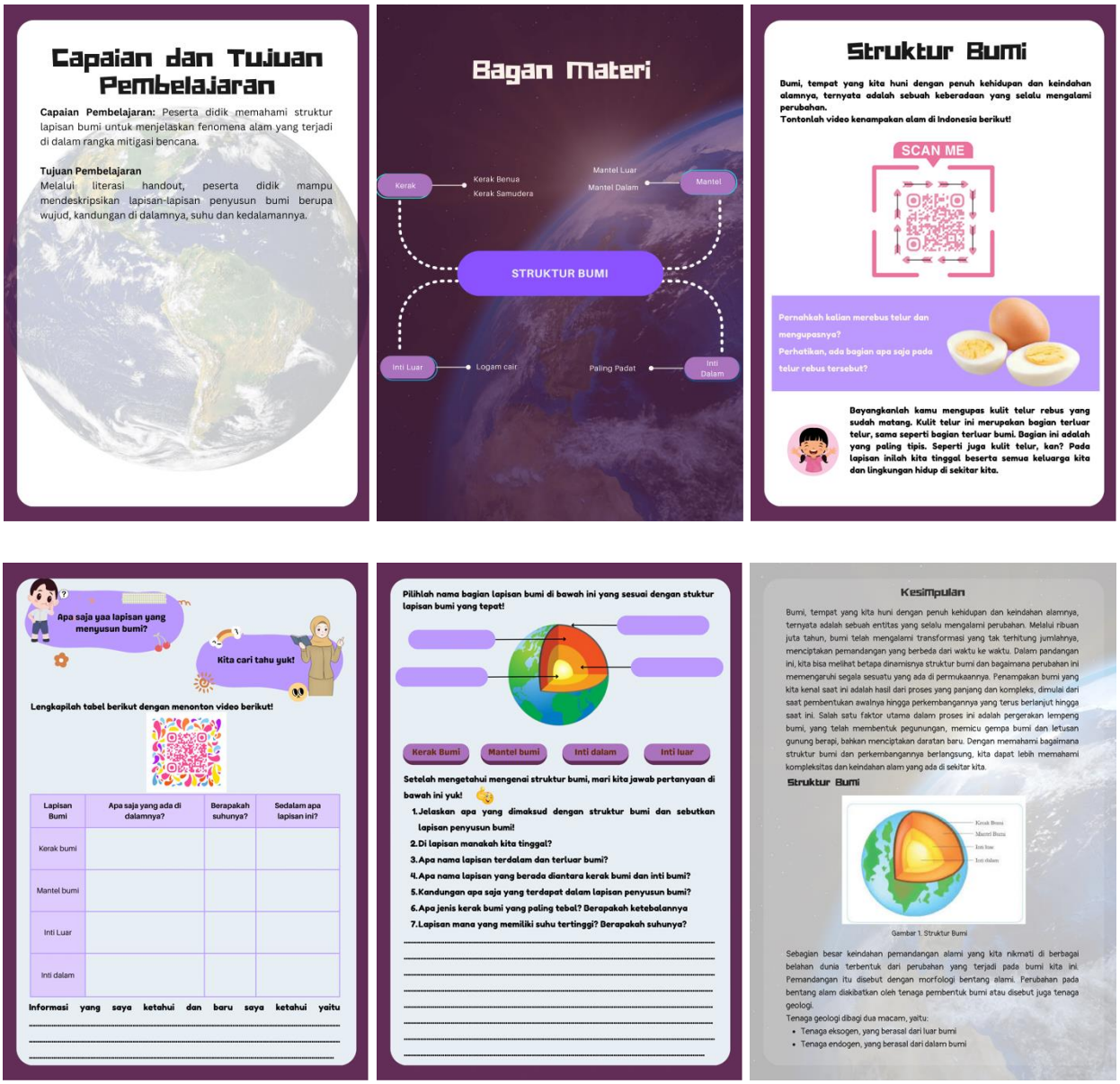


Figure 4.b. Discovery Learning-based Handout

Test and Evaluate

The fifth or final stage in design thinking is test and evaluation. At this stage, testing is carried out. After all designs are made, an assessment is carried out to validate the design solution. The testing process involves testing the prototype by experimenting with users (Wijaya et al., 2022). At this stage, validation tests were conducted on discovering learning-based handout teaching media to seven validators, namely lecturers of the Teacher Professional Study Program, University of Education Indonesia and teachers at SMP Negeri 2 Bandung. The validators have a minimum teaching experience of 3 years. At the time of validation, there were several suggestions from the validator regarding the content. The following are images of the product before and after validation.

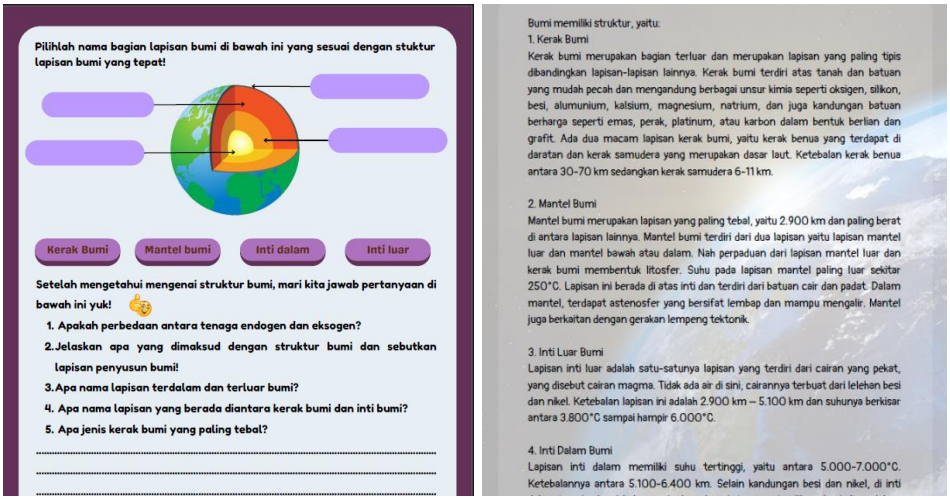


Figure 5. Handout Before Validation

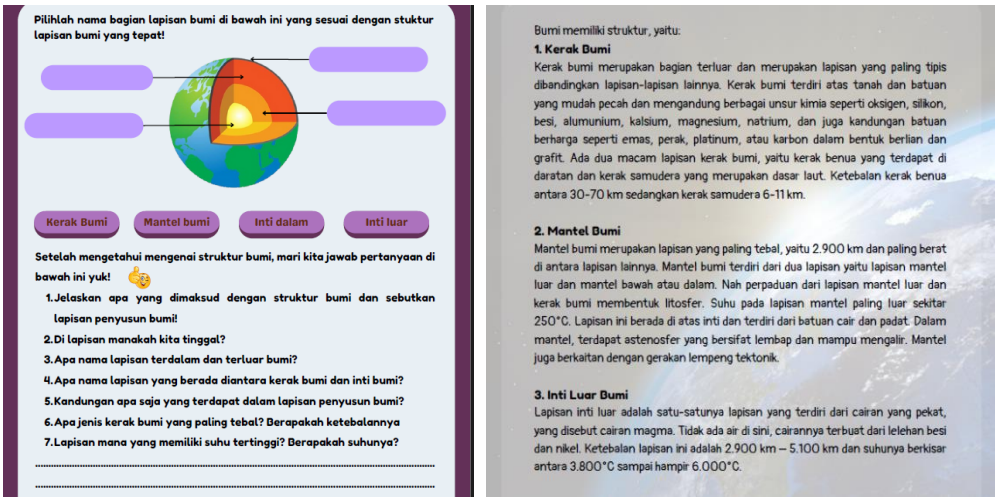


Figure 6. Handout After Validation

This validation was carried out by providing a validation sheet for each aspect of the assessment, consisting of three aspects. The results of the assessment are then entered into the following Table 4.

Table 4. Results of Validation of Discovery Learning-Based Handout Teaching Media

Validator	Number of Items	Tse	*Tsh*	Percentage (%)	Criteria
Validator 1	22	98	110	89	Very Valid
Validator 2	22	108	110	98	Very Valid
Validator 3	22	110	110	100	Very Valid
Validator 4	22	96	110	87	Very Valid
Validator 5	22	99	110	90	Very Valid

Validator	Number of Items	Tse	*Tsh*	Percentage (%)	Criteria
Validator 6	22	107	110	97	Very Valid
Validator 7	22	103	110	94	Very Valid
Percentage Total				**93,57**	**Very Valid**

Based on Table 4. It can be seen that the results of validation of discovery learning-based handout teaching media from the seven validators achieved a validity percentage of 93.57%, which falls under the 'very valid' criteria very valid. It shows that the discovery learning-based handout teaching media is valid for learning. Then, the discovery learning-based handout can be implemented in the classroom as a medium for learning to VIII grade students in one of the public junior high schools in Bandung City, as shown in Figure 7.

Figure 7. The Implementation of Discovery Learning-Based Handout Teaching Media

The learning activities shown in Figure 7 were carried out for 2 lesson hours or 80 minutes using discovery learning-based handout teaching media, which began with introductory activities, including greetings, prayers, student readiness, attendance, delivery of learning objectives, pretest work, apperception, and motivation. Core activities include activities based on discovery learning syntax, starting from stimulus, problem identification, data collection, data processing, proof, and conclusions. Closing activities include reflection and posttest.

The implementation of discovery learning-based handout teaching media is used to analyze student learning outcomes through material understanding tests. This test consists of a pretest and a posttest with ten multiple-choice questions. The pretest was conducted before students used the handout, while the posttest was conducted after using it. The implementation faced some challenges, namely, students had difficulty understanding the concepts independently without guidance from the teacher. To overcome this, the teacher gave directions on how to use the handout effectively. In addition, the time allocation was still insufficient because the learning was conducted during the first hour. Before learning, students do habituation at school so that it can take up time in the first lesson hour, so the teacher uses the time as much as possible so that the learning process runs effectively.

The effectiveness of discovery learning-based handout teaching media is determined by applying the N-gain score of student learning outcomes obtained through the pretest and posttest to determine the learning outcomes of students using the media. In line with what was revealed by (Safitri et al., 2022), the normalized gain score from the study can be used to assess the improvement of student learning outcomes (N-gain). The results of learning effectiveness can be seen in Table 5.

Table 5. Results of the Effectiveness Analysis of Discovery Learning-Based Handout Teaching Media

Component	Number of Students	Average Pretest Score	Average Posttest Score	Average N-gain	N-gain Category
Class VIII	32	41,25	74,06	0,56	Medium

Based on Table 5. it can be seen that the pretest score of class VIII students was an average of 41.25. In contrast, the posttest score reached 74.06 with N-gain effectiveness results of 0.56, which means the effectiveness of student learning is in the moderate category because N-gain is 0.3 to 0.69. This shows that using discovery learning-based handout teaching media effectively improves student learning outcomes.

The Validity of Discovery Learning-based Handout Teaching Media

Discovery learning-based handouts are teaching media in the form of teaching materials, including a summary of material and practice questions based on discovery learning syntax. In the learning process, this handout helps students develop concepts and find answers independently through practical actions or written tests. This assessment aims to measure students' abilities and understanding using the teaching media (Hasrah et al., 2022).

In this study, discovery learning-based handout teaching media were validated. Before being applied in classroom learning, this handout has been revised several times to make it suitable. Revisions were made to the material, questions, and problems presented to students because the previous questions were not fully by discovery learning, which prioritises student understanding in solving the problems given. The problems presented also did not fulfil the material discussed. After receiving input from the validator, the researcher improved the handout so that students could find and solve problems independently. Thus, the teaching media handout based on discovery learning was declared very valid and ready to be applied in classroom learning.

Based on the results of the validity test of learning instruments, the discovery learning-based handout teaching media reached a validity percentage of 93.57%, which was included in the very valid criteria. Therefore, it can be concluded that the discovery of learning-based handout teaching media is valid for use in research. In line with research conducted by Windiastuti et al. (2018), data analysis of learning devices in the form of teaching media developed is valid, practical, and effective in supporting the learning process. According to Akbar (2015), this statement emphasises that the handout teaching media products that have been validated come from various sources, including the content standards of the subject matter, language and linguistic aspects and have met all relevant criteria so that they can be categorised as very valid.

Effectiveness of discovery learning-based handout teaching media

Based on the research results, student learning outcomes from discovery learning-based handout teaching media on earth structure material are obtained from the pretest and posttest results. It can be seen in Table 4. that the pretest value of class VIII students was an average of 41.25. In contrast, the posttest value reached 74.06 with N-gain effectiveness results of 0.56, which means the effectiveness of student learning is in the moderate category because N-gain is 0.3 to 0.69. This handout can train students' cognitive abilities at the C2 level, namely understanding the learning objectives to be achieved. This shows that using discovery learning-based handout teaching media effectively improves student learning outcomes. The results obtained are relevant to previous research conducted by Hasrah et al. (2022), which revealed that the development of discovery learning-based handout teaching media was quite effective in the learning process. These two studies provide strong evidence that the discovery of learning-based handouts can effectively improve student learning outcomes, strengthening the validity and relevance of using this method in an educational context. Another study conducted by Umihani et al. (2023) revealed that discovery learning-based teaching media can be quite effective in use as learning media. According to Novitaningrum et al. (2014), the use of handout learning media that has been developed can improve student learning outcomes seen from the number of students who have achieved a complete score. Warni (2018) also stated that the use of handout teaching media is effective for students. This is evident from the completeness of good grades and the positive response to the handout.

CONCLUSION

Based on the research results, it can be concluded that the discovery learning-based handout teaching media uses a design thinking framework consisting of five principles, namely Empathize, Define, Ideate, Prototype, and Test & Evaluate. Analysis of the validity of discovery learning-based handout teaching media obtained a validity percentage of 93.57%, included in the very valid criteria. Analysis of the effectiveness of discovery learning-based handout teaching media with an N-gain score of 0.56, indicating moderate effectiveness, which means the effectiveness of student learning is in the medium category. This shows that using discovery learning-based handout teaching media effectively improves student learning outcomes. This research makes a significant contribution to the field of education by developing discovery learning-based handout teaching media to improve student learning outcomes on earth structure material that is systematically designed using the ADDIE model and design thinking framework. It provides clear and practical guidance for educators in creating more interesting and effective teaching media. This research provides practical guidance for educators in developing discovery learning-based teaching media and emphasizes the importance of applying the design thinking framework in the educational context, which can be adopted to develop other teaching media. Thus, this research contributes significantly to improving the quality of learning at the secondary education level, especially in Indonesia's science learning context. Based on the findings of this study, educators should implement discovery learning-based handout teaching media. For further research, exploring additional learning methods that can increase the effectiveness to a higher category in testing this media on various subjects and education levels is recommended to get more comprehensive results.

AUTHOR CONTRIBUTIONS

RSNA and AS conducted a study on designing and drafted an article. RSNA and S developed the Media product. All authors read and approved the final draft article.

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