



Accordion Book as an Innovative Learning Media to Improve Students' Understanding of Energy Transformation

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ABSTRAK

Masalah yang dihadapi dalam pembelajaran IPA, khususnya pada materi perubahan bentuk energi, adalah kesulitan siswa dalam memahami konsep-konsep abstrak yang sering kali sulit dipahami tanpa media yang tepat. Penelitian ini bertujuan untuk mengembangkan dan mengevaluasi efektivitas media pembelajaran Accordion Book pada materi tersebut untuk siswa kelas IV SD. Penelitian ini menggunakan model pengembangan ADDIE (Analysis, Design, Development, Implementation, Evaluation) untuk menghasilkan media yang inovatif dan menarik. Pengumpulan data dilakukan melalui validasi oleh ahli media dan materi, penilaian praktikalitas oleh guru dan siswa, serta uji efektivitas dengan pre-test dan post-test. Analisis data dilakukan dengan Aiken V untuk validitas, rumus rata-rata untuk praktikalitas, dan uji t-berpasangan untuk efektivitas. Hasil penelitian menunjukkan bahwa media Accordion Book memiliki validitas tinggi dengan skor Aiken V 0,95 untuk ahli media dan 0,94 untuk ahli materi. Praktikalitas media juga sangat baik, dengan skor rata-rata 3,8 dari guru dan 3,84 dari siswa. Uji efektivitas menunjukkan perbedaan yang signifikan antara nilai pre-test dan post-test siswa ($p < 0,05$). Kesimpulannya, penggunaan Accordion Book secara signifikan meningkatkan hasil belajar siswa pada materi perubahan bentuk energi. Media ini terbukti efektif dalam menyajikan materi secara visual dan kontekstual, memotivasi siswa untuk lebih aktif, dan meningkatkan pemahaman mereka terhadap konsep-konsep abstrak. Penelitian ini menyimpulkan bahwa Accordion Book dapat menjadi alternatif media pembelajaran yang inovatif dan efektif, serta dapat digunakan untuk materi IPA lainnya.

ABSTRAK

One of the challenges in science education, especially in the topic of energy transformation, is the difficulty students face in understanding abstract concepts that are often hard to grasp without appropriate media. This study aims to develop and evaluate the effectiveness of the Accordion Book learning media for this topic for grade IV elementary school students. This research uses the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation) to produce an innovative and engaging media. Data collection was carried out through validation by media and subject experts, practicality assessment by teachers and students, and effectiveness testing using pre-test and post-test. Data analysis was conducted using Aiken V for validity, average formula for practicality, and paired t-test for effectiveness. The results show that the Accordion Book media has high validity, with an Aiken V score of 0.95 for media experts and 0.94 for subject experts. The practicality of the media is also very good, with an average score of 3.8 from teachers and 3.84 from students. Effectiveness testing reveals a significant difference between the students' pre-test and post-test scores ($p < 0.05$). In conclusion, the use of the Accordion Book significantly improves students' learning outcomes on the topic of energy transformation. This media has proven effective in presenting the material in a visual and contextual manner, motivating students to be more active, and enhancing their understanding of abstract concepts. This study concludes that the Accordion Book can be an innovative and effective alternative learning media, and it can be applied to other science topics.

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1. INTRODUCTION

Education is a process that guides individuals based on their nature to become whole human beings, play a role in society, and achieve the highest level of safety and happiness. Education is a lifelong journey where we not only sharpen our cognitive and emotional abilities but also shape our character and identity as human beings (Bingimlas & Al-Gahtani, 2021; Biwer et al., 2020; Chu et al., 2017). In other words, education is a process of developing individuals holistically, both intellectually and socio-emotionally. The core aspect of education is its continuous nature. Lifelong learning is a process that extends beyond formal schooling, continuing throughout one's life and adapting to changes in life and the environment (Desianti & Rahayuningsih, 2022; Erlangga, 2022; Isdaryanti et al., 2018). From these definitions, we can conclude that education is a lifelong process aimed at developing individuals holistically. It goes beyond the mere transfer of knowledge, equipping individuals with skills and values relevant to the dynamics of life (Bingimlas & Al-Gahtani, 2021; Biwer et al., 2020; Chu et al., 2017; Supriani et al., 2022). This consciously and systematically designed learning process not only focuses on cognitive aspects but also encompasses emotional, social, and spiritual development. Education that is relevant to individual and societal needs, and that prepares individuals for the future, is key to shaping a generation that is adaptive, creative, and contributes to national progress (Kratz et al., 2019; Ostapenko et al., 2020).

Education cannot be separated from the learning process. Learning is a conscious activity undertaken by an individual to bring about a change in behavior towards their environment (Bingimlas & Al-Gahtani, 2021; Biwer et al., 2020; Choi et al., 2019; Chu et al., 2017). Learning is a crucial process in education, as it is where individual development and progress occur, where students not only acquire knowledge but also develop skills, attitudes, and values that will shape their character (Alkhatabi, 2017; Novita et al., 2022). The learning process allows students to experience questioning, exploration, and reflection, which are part of their cognitive and emotional growth. Through interactions with teachers and classmates, students learn to collaborate, solve problems, and think critically. Effective learning enables students to learn easily, enjoyably, and achieve learning objectives as expected, and encourages students to apply the knowledge they acquire in real-world situations, thus making them better prepared for future challenges (Chalkiadaki, 2018; Van Uum et al., 2017; Zakiyyah et al., 2021). Therefore, learning is not merely about mastering content, but also about developing competencies that will be useful in everyday life.

Based on observations and interviews at SDN 8 Karangasem and SDN 2 Tumbu, several things were found related to science learning on the material of Energy Transformation: the use of lecture methods, discussions, and demonstrations; a lack of creative and innovative learning media; students' interest in interactive learning media; and low student achievement in the material. The development of creative and innovative learning media, such as Accordion Books, can be an effective alternative to improve the quality of learning and achieve the desired learning objectives. In addition to being interesting, this media can help facilitate student understanding by considering content aspects that are appropriate to the needs and characteristics of students, as well as learning objectives. An Accordion Book is an innovative learning medium designed with a folding shape like an accordion. This concept was first introduced by Rumijdan in 2013. Uniquely, each fold in the accordion book serves as a mini-page that can contain various types of content, ranging from images, diagrams, explanatory texts, to practice questions.

Accordion books offer significant benefits to students. By using these books, students are able to record spontaneous ideas, connect different ideas, and explore thoughts freely (Afidah et al., 2019; Elkin & Mistry, 2022). In other words, these books serve as a tool to enhance students' creativity and understanding. Accordion books can also provide new learning experiences for students. With these new experiences, students certainly get interesting, non-monotonous, enjoyable, and more interactive learning (Ardiansyah & Nugraha, 2022). This medium was chosen because of its unique form, relevance to the learning material, affordable production costs, and its ability to support certain learning models such as Contextual Teaching and Learning (CTL) (Afidah et al., 2019). Despite all its advantages, accordion books also have drawbacks or weaknesses. A common weakness is physical damage. Due to its unique format, accordion books are more susceptible to physical damage, especially if not handled carefully. The folds can easily be damaged or torn, especially if the book is opened and closed frequently. However, this can be overcome by using strong and durable materials. The use of thick paper (cardboard) or similar materials can also be a solution.

The learning media used in both schools is still conventional and less attractive. This indicates a gap between students' needs for more interactive learning media and the variety of available media. The concept of energy transformation is sometimes difficult for students to visualize. This indicates a need for media that can present abstract concepts more concretely and interestingly (Andriani & Suratman, 2021; Ariani & Ujjanti, 2021; Suyanti et al., 2021). Based on the description, the researcher is interested in developing an Accordion Book learning media for the Science subject, specifically on the material of energy transformation. Unlike the conventional books used in both elementary schools, the development of this Accordion Book learning media presents a novelty by presenting it in the form of an adventure story on a mysterious island that contains the concepts of energy transformation. Presented with interesting images

and illustrations, there are several characters who are likened to guides for students in learning to understand the concept of energy transformation. There is also technology in the form of a barcode (QR Code) that students can use to measure their understanding of the material in the Accordion Book learning media (Afidah et al., 2019; Elkin & Mistry, 2022). Thus, students can increase their motivation and learning outcomes by using Accordion Book learning media. This is what makes the development of the Accordion Book media different from previous research. In addition, the development of this learning media also has a very high urgency. The concept of energy transformation is sometimes difficult for students to visualize.

Books with interesting pictures and diagrams can help students understand this concept more concretely (Hiralda & Zulherman, 2023; Lawson-Body et al., 2020). This media encourages students to be actively involved in the learning process (Pribadi et al., 2021; Sumirat & Alamsyah, 2017). Students can read, observe pictures, and even take notes directly on the accordion book. By presenting information in a structured and visual way, accordion books help students build a stronger and deeper understanding of the learning material (Elkin & Mistry, 2022). In addition, with the existence of this learning media, which is classified as print learning media, it is able to overcome the limitations of facilities and infrastructure, this is a facility that directly affects the success of students in achieving learning objectives (Setiyaningsih & Syamsudin, 2019; Wandini et al., 2020). Therefore, it is necessary to have the "development of Accordion Book learning media on the Science material on the topic of understanding energy transformation to improve the learning outcomes of students at SDN 8 Karangasem". The purpose of developing this media is to produce an Accordion Book for the Science material on the topic of understanding energy transformation for grade 4 elementary school, analyze the feasibility of the Accordion Book for the Science material on the topic of understanding energy transformation for grade 4 elementary school, analyze the practicality of the Accordion Book for the Science material on the topic of understanding energy transformation for grade 4 elementary school, and analyze the effectiveness of the Accordion Book for the Science material on the topic of understanding energy transformation in improving learning outcomes of grade 4 elementary school students.

2. METHOD

The development model used in this research is the ADDIE model. The ADDIE model applies a systematic approach to instructional planning (Suryanti et al., 2024). The core of this approach is to divide the planning process into a series of logically structured steps, where each step is designed to provide an output that is then used as input for the next step. With such an approach, each stage in instructional planning can be more directed and mutually supportive. In the ADDIE model, there are five main stages: Analysis, Design, Development, Implementation, and Evaluation. In the Analysis stage, the needs and characteristics of the learners and the learning objectives are identified to understand the basis for the planning that will be made. The Design stage involves creating a more detailed plan, such as setting specific goals, designing content, selecting appropriate media, and evaluation methods. In the Development stage, the learning materials and media that have been planned are created and compiled. Implementation involves the use and application of the developed materials in the classroom, where educators and learners are directly involved in the learning process. Finally, the Evaluation stage serves to assess the effectiveness and efficiency of learning, both in terms of the process and the results achieved, so that improvements can be made as needed. In this media development research, validation testing was conducted by material experts and media experts to evaluate the validity of the developed media. The following is the validity instrument for the developed media. Media Expert Rating Scale Blueprint showed in Table 1.

Table 1. Media Expert Rating Scale Blueprint

Aspect	Components	Number of grains
View	Attractiveness of product appearance.	2
Text Image	Suitability of design to student characteristics.	3
	Suitability of font size.	
Color	Text readability.	2
	Suitability of font type.	
Layout	Clarity of images.	2
	Image suitability.	
	Text color suitability.	
View	Image color suitability.	1
	Text layout is consistent on each page	
	Component layout on each page	
View	Ease of use of the product.	1

This research aims to develop an Accordion Book learning media for the science subject, specifically on the topic of understanding energy transformations, to improve the learning outcomes of fourth-grade elementary school students. After that, the product was tested on teachers and students to gather their feedback on the developed media. Media validity testing involved 3 subject matter experts and 3 media experts, while teacher and student response testing involved 3 teachers and 9 students from grade 4 of SDN 8 Karangasem Elementary School. In this development research, data analysis was conducted to obtain a concrete understanding of the success of the Accordion Book learning media for the science material on the topic of understanding energy transformation to improve the learning outcomes of fourth-grade elementary school students that had been developed. The results obtained were used as a consideration for making improvements to the Accordion Book. In this development research, there were two data analysis methods used, namely quantitative descriptive analysis and qualitative descriptive analysis. In this study, qualitative descriptive analysis was used to process data in the form of respondent feedback (suggestions/criticism/notes), while quantitative descriptive analysis was used to process data from questionnaires and test sheets. The quantitative and qualitative descriptive data were obtained from three types of data, namely validity data, practicality, and effectiveness. In this media development research, the quantitative descriptive analysis method was used to process data obtained from respondents, such as scores given by experts, teacher responses, and student responses through previously given instruments. The category of Likert scale assessment used in this development research showed in Table 2.

Table 2. Likert Scale Rating Categories

No	Score	Description
1	Score 1	Strongly Disagree
2	Score 2	Disagree
3	Score 3	Agree
4	Score 4	Strongly Agree

(Dewi & Sujana, 2021)

Afterwards, the overall scores were converted into a percentage range and a four-point qualitative PAP criterion to provide a description and for decision-making regarding the validity of the developed media, whether it is valid or not. The range of percentages and the four-point qualitative PAP criteria in Table 3.

Table 3. Conversion of Validity Achievement Level with a 4-Point Scale

No	Achievement Level (%)	Qualification	Description
1	86% - 100%	Very Practical	Can be used without revision
2	70% - 85%	Fairly Practical	Can be used with minor revisions
3	60% - 69%	Not Practical	Cannot be used
4	0% - 59%	Very Impractical	Cannot be used

3. RESULT AND DISCUSSION

Results

In the development of the Accordion Book media, there were five activities conducted. The first activity was analysis. This analysis aimed to gather information regarding the needs required for the use of Accordion Books. The initial step involved conducting a needs analysis of the Accordion Book during the learning process, which was carried out collaboratively with teachers and students at the elementary school. This analysis aimed to find solutions related to the problem of low student learning outcomes caused by a lack of motivation due to the use of monotonous learning media. This analysis activity was conducted using the interview method. At this stage, the researcher designed and created the Accordion Book using a software application called Canva.

At this development stage, we began to gather the necessary tools and materials for the production of the Accordion Book learning media. Once the accordion book had been fully developed and its validity had been confirmed by experts in the field, it was then implemented in a science learning activity for fourth-grade students at SD Negeri 8 Karangasem. The purpose of this field test was to determine the impact and effectiveness of the accordion book. This stage aims to determine the feasibility and achievement of the objectives of developing the accordion book learning media to assist in the learning process of the science subject, specifically on the topic of understanding energy transformations, for fourth-grade students. The evaluation stage was carried out using a combination of validator assessments, practitioner responses, and small-group trials of the accordion book product. This allowed for the identification of the product's

strengths and weaknesses, enabling appropriate actions to be taken to make necessary improvements and enhance the product for future use.

In the development of the Accordion Book media, an analysis was conducted beforehand to ensure that the developed media met the requirements and needs of media development. The development of the Accordion Book learning media began with creating a design using the Canva application to visualize the sketch of the Accordion Book, aiming to see the overview of each page in the Accordion Book. After completing these stages, the creation of the Accordion Book learning media continued, using simple tools and materials. The tools and materials used were laminating stickers, cardboard, a cutter, and a squeegee. The Accordion Book learning media for the science subject, specifically on the topic of understanding energy transformations to improve the learning outcomes of fourth-grade elementary school students, consisted of 8 parts, including (1) Cover, (2) Instructions Page, (3) Learning Outcomes Page, (4) Author Biography Page, (5) Mysterious Island Exploration Story Page, (6) Conclusion Page, (7) Quiz Page, and (8) Closing Page. The development results are presented in Figure 1.



Figure 1. Media Development Results

The developed accordion book was subsequently validated, tested for practicality, and evaluated for its effectiveness using a questionnaire. The media's validity was initially assessed by three experts in media and subject matter. The Accordion Book received a high validity score of 0.95 from media experts and 0.94 from material experts, indicating a very high qualification as a learning medium. This is because the learning media features attractive colors, cartoon characters, suitable images, and fonts that are appropriate for the characteristics of fourth-grade elementary students. In addition to explanations, there is also an interesting storyline and a short quiz to test students' understanding. The quiz is provided in digital form using the Wordwall platform, and access is facilitated by a QR code so that students can work through their smartphones.

The accordion book received a high validity score of 0.95 from media experts and 0.94 from content experts, indicating its exceptional suitability as a learning medium. This is attributed to the media's engaging use of colors, cartoon characters, relevant images, and a font size appropriate for fourth-grade elementary students. In addition to explanations, the accordion book features an interesting storyline and brief quizzes to assess student comprehension. The quizzes are provided in digital format using the Wordwall platform and can be easily accessed through QR codes, allowing students to complete them using their smartphones. After validation, the practicality of the Accordion Book was tested at SDN 8 Karangasem by three teachers (grades 4, 5, and 6) and nine fourth-grade students. The results showed an average rating of 3.8 from teachers and 3.84 from students, which is qualified as very good. The book is easy to use thanks to clear instructions and the support of school facilities, such as Wi-Fi and permission to use smartphones. The Accordion Book was considered effective in helping students understand the material on energy transformations, which contributed to improved learning outcomes.

After conducting feasibility and practicality tests and revisions based on validator input, an effectiveness test was conducted on students at SDN 8 Karangasem. The effectiveness of the Accordion Book was tested using a method of answering 20 multiple-choice questions given to students before and after using the Accordion Book. The results of the homogeneity test show a value of 0.07, so $0.07 > 0.05$ so the data is homogeneous. The scores obtained by the students after filling out the answer sheets were analyzed using the paired t-test technique on the IBM SPSS version 25 application. The results of the analysis of student learning outcomes obtained a sig. value (2-tailed) of 0.000. This value is smaller than 0.05 (significance level of 5%), it can be concluded that there is a significant difference before and after the treatment of the Accordion Book on student learning outcomes. The use of the Accordion Book learning media can make students more active because this media is still considered a new innovation in learning media.

Discussion

Based on the results of the research that has been conducted, the development of the Accordion Book learning media for grade IV science material on energy transformation material is suitable for use in learning. This can be seen from the validity, practicality, and effectiveness tests, which show very good results. The high validity test results indicate that the developed Accordion Book meets the criteria for good learning media (Purnamasari & Wuryandani, 2019; Suryani et al., 2021). This means the media is based on the learning objectives, teaching materials, and learning media (Elmunsyah et al., 2019; Prasetya et al., 2018). The developed Accordion Book also needs to be tested for its suitability with the applicable curriculum. This is important to ensure that the media can support the achievement of the basic competencies set. An in-depth evaluation of the material's content in the Accordion Book needs to be done. The material must be accurate, relevant, and presented in language that is easy for students to understand. The Accordion Book's attractive and interactive visual design also contributes to the validity of the media. Visual elements such as images, illustrations, and attractive layouts can increase students' interest in learning (Canuto et al., 2024; Elmunsyah et al., 2019; Febriani et al., 2022; Prasetya et al., 2018).

The results of the practicality test from both teachers and students show that the Accordion Book is easy to use and can support the learning process in the classroom. This indicates that the media can be an enjoyable and effective alternative to delivering learning materials (Budiaman et al., 2021; Xia et al., 2023). In addition to the ease of use by teachers, it is also necessary to pay attention to the ease of students using the Accordion Book independently. This can be done by providing precise and simple instructions (Hadaya et al., 2018; Lawson-Body et al., 2020). The flexibly designed Accordion Book can be used in various individual and group learning situations. The availability of supporting facilities such as projectors or digital devices can increase the Accordion Book's effectiveness. The effectiveness test results show that using the Accordion Book can improve student learning outcomes in the energy transformation material. This means the media can improve student learning outcomes (Setiyaningsih & Syamsudin, 2019; Solchan Ghazali et al., 2022; Sumirat & Alamsyah, 2017). In addition to improving learning outcomes, the Accordion Book can increase student learning motivation. This can happen because the media used is engaging, interactive, and can provide a fun learning experience. The Accordion Book can help students develop various skills, such as reading, writing, critical thinking, and teamwork (Setiyaningsih & Syamsudin, 2019; Wandini et al., 2020). Consistent use of the Accordion Book can positively impact students' attitudes towards science learning. Students can become more interested in and enjoy science subjects.

This research contributes positively to the development of innovative and engaging learning media. The Accordion Book can be an example of the development of text and image-based learning media that can be adapted to various learning materials. Teachers can use the Accordion Book as an alternative learning media to increase student motivation and participation in the learning process. Further research can be done by developing the Accordion Book in other subjects or involving a larger student population. Similar research can be done on different learning materials or at different levels of education to generalize the study results. The Accordion Book can be further developed by adding interactive media. Features, such as video, animation, or online quizzes. Teachers must be given adequate training on using and developing learning media such as the Accordion Book. The Accordion Book must be integrated with the applicable curriculum to provide optimal student benefits. Digital technology can increase the appeal and effectiveness of the Accordion Book.

4. CONCLUSION

The results of the data analysis show that the Accordion Book learning media on the topic of science understanding energy transformation effectively gets very valid qualifications from experts and is practical from students. The results of the effectiveness test show that there is a significant difference in student learning outcomes on the material of energy transformation before and after being taught using the Accordion Book. Thus, the use of the Accordion Book learning media on the topic of science understanding energy transformation is effective in improving student learning outcomes.

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