



Development of Koperwuz Media Incorporating the Nature of Science (NOS) to Improve Learning Outcomes of Fourth Grade Elementary School Students

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Abstract

Low student achievement and limited engagement in science classes, particularly on the topic of changes in the state of matter, prompted this study. Teachers have continued to rely on conventional instructional methods, with teaching materials primarily sourced from textbooks. Existing media have not succeeded in improving learning outcomes, and instructional processes rarely connect scientific concepts to students' everyday experiences. This research aims to evaluate the validity, practicality, and effectiveness of the Koperwuz instructional comic, which incorporates the Nature of Science (NoS) approach, in enhancing student performance on the topic of phase changes in fourth-grade classes at SDN Tarokan 4 Kediri. The study adopted a Research and Development (R&D) methodology, following the ADDIE development framework. Validation was conducted by subject matter and media experts. Practicality was assessed through large-scale questionnaires completed by both teachers and students, while effectiveness was measured using pretest and posttest scores from a broad trial group. The findings indicate that the Koperwuz comic achieved high validation scores from both media (88%) and subject experts (100%), categorizing it as highly valid. Teacher responses yielded a practicality score of 87%, while students rated it at 75%, suggesting the medium is practical for classroom use. Analysis of learning outcomes showed a significant improvement, with average pretest and posttest scores rising from 60.8 to 90.1. The calculated N-Gain score was 0.7639, classified as high, and the N-Gain percentage reached 76.39%, indicating the medium's effectiveness. These results support the conclusion that the NoS-based Koperwuz comic is a viable tool for improving science learning outcomes among fourth-grade students.

Keywords: Koperwuz; Nature of Science; Learning Outcomes; Phase Changes.

Introduction

Education is one of the fundamental keys to advancing and enlightening humanity. Achieving high-quality human resources requires an equally high-quality education (Helena, 2017). Education serves not only to enhance students' intellectual abilities but also to shape their morals, character, behavior, attitudes, and the civilization of a dignified nation, all in pursuit of a more democratic and responsible society (Asyafiq, 2016). Thus, to foster progress and intellectual development, quality education is indispensable. The overall standard of education is directly influenced by the quality of teaching and the processes that support comprehensive character and skill development in students. Learning is understood as an interactive process involving students, teachers, and learning resources within an educational environment (Nadliyah *et al.*, 2019). It is a process designed to help students achieve specific learning objectives. These objectives reflect the intended outcomes of an educational experience. To facilitate effective classroom learning, teachers require appropriate instructional media. According to Ambarwati *et al.* (2022), media can be defined as anything that consultants use to convey messages to an audience, thereby creating a supportive learning



environment. Sahib *et al.* (2023) further describe instructional media as tools for transmitting information from teachers to students, available in both print and audio formats. Given their role in facilitating communication, instructional media occupy a crucial position in the learning process. Despite this, many educators still rely on conventional media, such as chalkboards and whiteboards, or readily available materials like wall charts, posters, and maps. This dependence often diminishes teachers' creativity and can negatively impact student interest in learning. Frequently, these media lack contextual relevance, fail to engage students, and tend to be monotonous.

Observations and interviews with fourth-grade teachers revealed that instructional methods remain limited, predominantly using lectures and group discussions. Teaching materials are mostly textbook-based, focusing solely on content and exercises without practical science activities. Existing media have not succeeded in improving learning outcomes, and lessons rarely connect scientific concepts with real-life contexts. The average score for students' daily assessments on the topic of phase changes was 58.25, indicating that most students had not met the Minimum Mastery Criteria (KKTP), set at 70. Out of 40 students, only 23% (9 students) achieved the target, while 77% (31 students) did not. These findings highlight several issues at SDN Tarokan 4: the continued use of conventional teaching methods, ineffective instructional media, and a lack of real-world connections in science lessons. To address these challenges, there is a pressing need to develop innovative instructional media. In response, the researcher designed a comic-based medium that integrates science concepts with everyday life.

The development of Koperwuz (Comic on Phase Changes) incorporating the Nature of Science (NoS) aims to guide students toward learning objectives and address the aforementioned issues. This medium is expected to make science learning more accessible, reduce student boredom with existing materials, support observation and experimentation, and ultimately enhance knowledge acquisition at the elementary level. Kustiwan (2016) notes that comics offer several advantages as instructional media: they are simple and easy to produce, materials are readily available, they can present data or summaries accompanied by visuals, overcome time and space constraints, require no special equipment, are clear without needing additional explanations, and can be combined with other graphic media. However, comics also have drawbacks, such as being prone to damage (since they are made of paper), requiring specialized skills to create, and being time-consuming to produce (Ananda *et al.*, 2023). Effective instructional media should meet various criteria, including attractive design, relevant content, ease of use, and the ability to help students grasp concepts and support observation and experimentation. Incorporating real-life examples can also encourage students to construct their own understanding (Azhari *et al.*, 2022).

Previous research by Supriyanto (2015) entitled "Development of Comic Media for Social Studies on the History of Indonesia's Independence Preparation in Grade V of SD Muhammadiyah Muthan Wates Kulon Progo" found that, at various stages of field testing, the developed comic media consistently received high scores and was considered effective in attracting students' attention, facilitating learning, and aiding memory retention. Another study, "Development of Digital Practicum Modules Based on the Nature of Science (NoS) to Improve Higher Order Thinking Skills (HOTS)" by Mahendra Dinatha & Kua (2019), concluded that the developed modules, which integrated NoS, were of high quality and effectively enhanced students' higher-order thinking skills in basic chemistry practicum courses. While previous studies have demonstrated the effectiveness of comics and NoS-based media, there remain significant gaps: Supriyanto (2015) focused on comic media without a NoS component, whereas Mahendra Dinatha & Kua (2019) addressed NoS but not through comic media.

This study offers a novel contribution by combining comic media with the Nature of Science approach for elementary science education, specifically addressing the topic of phase changes for fourth-grade students—a combination that has been largely unexplored in prior research. Therefore, the development of NoS-based comic media is not only timely but also necessary, as it merges in-depth scientific concepts with an engaging and accessible format for young learners. In line with this rationale, the present study is titled "Development of Koperwuz Instructional Media Incorporating the Nature of Science (NoS) to Improve Learning Outcomes of Fourth-Grade Students at SDN Tarokan 4."



Literature Review

In the learning process, the achievement of educational goals depends not only on the content and methods employed, but also on the supporting tools that facilitate effective teaching. One of the most important of these tools is instructional media. Media play a vital role in creating an interactive, engaging, and meaningful learning environment. With the help of well-chosen media, teachers can deliver information in a more systematic and accessible manner, making it easier for students to understand. The selection of appropriate media can enhance the effectiveness of instruction and strengthen student engagement throughout the learning process. Instructional media serve as a bridge for transferring information from educators to students in an effective way. Djamarah & Azwan (2020) define instructional media as any aids that can be used to channel messages in order to achieve learning objectives. Similarly, Arina *et al.* (2020) describe instructional media as any form of tool used to clarify information so that it is more easily understood by students. The right use of media supports the achievement of learning goals, makes material delivery more efficient, and increases student participation. In this context, instructional media function not only as visual aids, but also as stimuli that can spark students' interest, attention, and comprehension of the subject matter (Latief *et al.*, 2022). One particularly engaging form of instructional media is the comic. Comics have been widely adopted in educational settings due to their visual and narrative qualities, as well as their accessibility for elementary school students. Comics can be described as stories that emphasize movement and action, presented through a sequence of distinct images accompanied by text (Nurgiyantoro, 2013). The process of creating comic-based instructional media involves a series of systematic creative steps. According to Rahmanto *et al.* (2019), there are six stages in comic creation: formulating story ideas and developing characters, organizing the story sequence, sketching, inking, coloring, and adding text (lettering). Each stage must be carefully designed so that the educational message is effectively and attractively conveyed to students.

In the context of science education, it is essential for instructional media to integrate elements of the Nature of Science (NoS). NoS refers to the fundamental characteristics of science, encompassing philosophical, historical, and sociological perspectives on the development of scientific knowledge. Siregar (2016) notes that NoS provides a complex understanding of how science evolves as part of human activity. Oka Wardhana *et al.* (2022) outline that NoS-based learning involves several stages, including background readings, case study discussions, inquiry-based lessons, laboratory inquiries, historical studies, and assignments. This approach enables students to grasp not only the content but also the scientific processes underlying the formation of knowledge. The effectiveness of instructional media can be measured by student learning outcomes, which serve as a primary indicator of the success of the educational process. Achdiyati (2017) defines learning outcomes as the abilities acquired by children through learning activities, encompassing interconnected cognitive, affective, and psychomotor domains. Therefore, engaging and relevant instructional media are crucial for improving comprehensive student achievement. In this regard, Natural Sciences (IPA) is a subject that requires a contextual and hands-on approach. Wardani *et al.* (2022) state that science uses the surrounding environment as a source of learning. Science education examines everyday situations and encourages students to solve problems through scientific methods. Understanding scientific concepts, such as changes in the state of matter, requires media that can present these processes in a concrete way. Thus, the use of comics enriched with NoS content is an appropriate innovation to help students grasp the concept of phase changes in an enjoyable and meaningful manner.

Methodology

This research employed the Research and Development (R&D) method. As stated by Borg and Gall (as cited in Sugiyono, 2015:407), the R&D method is used to produce a particular product, which is then tested for its validity, practicality, and effectiveness. The instruments used in this study included teacher and student practicality questionnaires, validity assessment questionnaires, and tests. The student questionnaire was designed to evaluate whether the comic-based media was engaging, easy to use, and helpful in understanding the material. The teacher questionnaire, on the other hand, aimed to capture teachers' perspectives regarding the ease of using the media in science instruction.



Table 1. Student Questionnaire

No.	Aspect	Indicator	Options	
			Yes	No
1	Content	The material in the comic media is clear and easy to understand		
2		The content aligns with the structure and objectives of the lesson		
3		Examples in the comic are relevant to students' daily lives		
4		The comic illustrates the application of phase changes in daily life and their relation to the Nature of Science		
5	Language	The language used in the comic is communicative		
6		The language is clear and easy to understand		
7	Media	The comic helps in understanding phase changes, especially in practice or skills		
8		The comic can be used independently		
9		The comic's appearance is very attractive		
10		The combination of colors and images in the comic is clear and appealing		
Total Score				
Maximum Score				
Percentage				

Source: Izza, 2023.

Table 2. Teacher Questionnaire

No.	Aspect	Indicator	Score				
			1	2	3	4	5
1	Curriculum	Alignment with learning outcomes					
2		Alignment with instructional objectives					
3	Content	Content matches students' cognitive abilities					
4		Phase change material in the comic is easy to understand					
5	Language	The language used is simple					
6		Terms in the comic are clear and understandable					
7		Font type and size are legible					
8	Appearance	Illustrations are clear and engaging					
9		Color and text composition is proportional and consistent					
10	Presentation	Alignment between NoS aspects and phase change concepts					
11		NoS aspects are interesting and easy to understand					
12		The comic can be used independently by students					
13		The comic helps students understand the concept of phase changes					
14		The comic encourages student interest in learning about phase changes					
15	The comic is practical and facilitates student learning						
Total Score							
Maximum Score							
Percentage							

Source: Izza, 2023.



The teacher response and validity questionnaires use a Likert scale ranging from 1 to 5:

Table 3. Likert Scale

Score	Criteria
1	Very Poor
2	Poor
3	Fair
4	Good
5	Excellent

The student response questionnaire uses a Guttman scale. According to Sugiyono (2014:139), the Guttman scale is designed to obtain definitive answers from respondents, with only two options (yes-no, agree-disagree). A score of 1 is assigned for "Yes" and 0 for "No". After teachers and students complete the questionnaires, the data are analyzed by calculating the percentage of scores for each item using the following formula:

$$P = \frac{x}{y} \times 100\%$$

Where:

P = Practicality aspect value

X = Score obtained

Y = Maximum possible score

The results are then converted according to the following criteria:

Table 4. Practicality Assessment Qualification

Interval	Category
0% - 20%	Not Practical
21% - 40%	Less Practical
41% - 60%	Fairly Practical
61% - 80%	Practical
81% - 100%	Highly Practical

Source: Riduwan, 2015.

For expert validation (media and content), the questionnaires are structured as statements rated by validators using a Likert scale. The indicators are as follows:

Table 5. Media Expert Validation Questionnaire

No.	Aspect	Indikator	Score
1	Comic Appearance	Form, size, neatness, attractiveness, harmony of background and text color, clarity of writing, relevance to learning theme	1 2 3 4 5
2	Media Use	Clarity of instructions, ease of use	
3	Content	Alignment with learning outcomes and objectives, clarity, contextual examples	
Total Score			
Maximum Score			
Percentage			

Source: Ariyani, 2021.



Table 6. Content Expert Validation Questionnaire

No.	Aspect	Indikator	Score				
			1	2	3	4	5
1	Learning	Relevance to objectives, systematic presentation					
2	Content	Alignment with formulation, appropriateness for student level, clarity, specificity, relevant images and examples					
3	Language	Sentence effectiveness, conceptual clarity					
Total Score							
Maximum Score							
Percentage							

Source: Ariyani, 2021.

According to Riduwan (2015), the percentage of validation results from expert questionnaires is calculated as follows:

Table 7. Media Validity Criteria

Interval	Criteria
0% - 20%	Not Valid
21% - 40%	Less Valid
41% - 60%	Fairly Valid
61% - 80%	Valid
81% - 100%	Highly Valid

Source: Riduwan, 2015.

Statistical analysis of N-Gain was conducted using SPSS for Windows. The N-Gain test measures the effectiveness of an intervention in improving student learning outcomes by comparing pretest and posttest scores. According to Sukarelawan *et al.* (2024:10), the N-Gain formula is as follows:

$$NGain = \frac{Posttest\ Score - Pretest\ Score}{Ideal\ Score - Pretest\ Score}$$

Where:

N-Gain = Normalized gain

Pretest = Initial score

Posttest = Final score

The magnitude of the N-Gain score can be interpreted as follows:

Table 8. Normalized Gain Criteria

N-Gain Value	Interpretation
$0.70 \leq g \leq 1.00$	High
$0.30 \leq g < 0.70$	Medium
$0.00 < g < 0.30$	Low

Source: Sukarelawan *et al.*, 2024.

Table 9. Effectiveness Criteria

Percentage (%)	Interpretation
<40	Not Effective
40-55	Less Effective
56-75	Fairly Effective
>76	Effective

Source: Sukarelawan *et al.*, 2024.



The development model used in this study is based on the ADDIE model. The ADDIE model offers a straightforward framework for instructional design that can be applied to various products due to its general structure (Tegeh *et al.*, 2014). The stages of the ADDIE model include:

- 1) Analysis
The initial step involves analyzing students' learning styles, existing competencies, and identifying problems within the learning process.
- 2) Design
After conducting observations and interviews and reviewing documentation of student learning outcomes, the next step is to design the media by selecting appropriate content, determining delivery methods, and aligning with targeted competencies.
- 3) Development
At this stage, the researcher realizes the development ideas based on the prior design, ensuring that the media meets instructional needs.
- 4) Implementation
The developed media is then implemented in the learning process. Before full-scale use, the media undergoes validation and practicality testing.
- 5) Evaluation
The final stage emphasizes ongoing evaluation to refine and optimize the instructional media for effective use.

The research design employed was a one-group pretest-posttest design, a type of pre-experimental design (Sukarelawan *et al.*, 2024). The study was carried out from November 2024 to June 2025 at SDN Tarokan 4. The participants included 4th-grade students, with a limited trial involving 10 students and a broader trial with 30 students, as well as 4th-grade teachers at SDN Tarokan 4. This research adhered to ethical principles, including institutional approval, participant consent, data confidentiality, and non-maleficence. Prior to implementation, the researcher obtained a research permit letter from the university's LPPM office, followed by permission from the principal of SDN Tarokan 4. Approval from the school principal was the basis for conducting field activities. Teachers and 4th-grade students were informed about the study's aims and procedures. Participation was voluntary and free from coercion. For students, parental and school approval was required, considering their age. All participant data was kept confidential, and identities were anonymized in all reports. The research was designed to avoid any negative physical or psychological impacts, ensuring a safe and enjoyable learning environment. Data analysis in this study involved both qualitative and quantitative descriptive techniques. According to Wenda (2016), qualitative analysis was used to process data from expert validation feedback, while quantitative analysis was used for questionnaire and test results. Data collection methods included expert validation forms, teacher and student response questionnaires to assess practicality, and pretest-posttest assessments to evaluate the effectiveness of the media in improving learning outcomes.

Results and Discussion

Results

After the Koperwuz instructional media, which incorporates the Nature of Science (NoS), was developed, a series of validity, practicality, and effectiveness tests were conducted to assess its quality and impact on learning. This section presents the results of each phase along with their discussion, aiming to determine the extent to which this media can enhance students' understanding and learning outcomes.

1) Analysis

The analysis phase was conducted as the initial step in the research process, with the aim of gathering the necessary data to design the instructional media. The study began with observations at SDN Tarokan 4. During this stage, the researcher performed both performance and needs analyses. The performance analysis examined the current state of instruction and evaluated the effectiveness of science teaching on the topic of phase changes in matter in grade IV at SDN Tarokan 4. Field observations revealed that instruction was not yet student-centered. This was due to the continued use of conventional, less engaging teaching methods, resulting in low student engagement during lessons.



Teachers also faced challenges in presenting material concretely, primarily due to the lack of adequate media, especially for explaining abstract concepts such as phase changes. These findings indicate that instructional performance was suboptimal and that innovation in media use—making it more engaging, contextual, and aligned with the characteristics of the subject matter and students—is urgently needed. The needs analysis aimed to identify key aspects to be developed in designing effective instructional media tailored to students' characteristics. The analysis found that many grade IV students still struggled to understand the concept of phase changes. This was supported by documentation of student learning outcomes, which showed achievements below the minimum competency standards. It can be concluded that there is an urgent need for more contextual and visual instructional media that can explain the material more concretely and increase active student participation. Therefore, the development of contextual and engaging media, such as the Koperwuz (Komik Perubahan Wujud Zat) comic, is considered essential to support more effective learning and is expected to significantly improve student outcomes.

2) Design

During the design phase, the researcher planned the development activities for the instructional media. The main focus was on designing the structure and elements to be included in the media. The key activities in designing Koperwuz included:

- 1) Determining Learning Outcomes, referring to the competencies expected of students after using the media. These outcomes are based on the national curriculum, specifically: "Students identify the processes of phase changes and energy transformations in everyday life."
- 2) Formulating Learning Objectives and Content, based on the defined learning outcomes. The selection of content was aligned with these outcomes and the students' cognitive development. For Koperwuz, the content focused on six types of phase changes: melting, freezing, evaporation, condensation, crystallization, and sublimation. Besides defining each type, the material included concrete examples from daily life. The content was organized narratively and visually, using child-friendly characters to convey scientific concepts in accessible language.
- 3) Designing the Comic Storyline, creating scenarios that incorporate phase changes, such as a child experiencing events related to states of matter at home and discussing them at school, complemented by illustrations of the processes.
- 4) Determining the Visual and Artistic Style, with child-friendly illustrations set in a school context. The color scheme used red, orange, and blue for variety within the comic, while the front and back covers featured blue. Characters and backgrounds were designed to reflect typical students, supporting comprehension. Illustrations were included to visualize each phase change.

Table 10. Koperwuz Media Design

<p>KOPERWUZ Komik Perubahan Wujud Zat</p> <p>Komik Pembelajaran</p> <p>"Apakah belajar masih barengan?"</p> <p>Sekolah kelas 4</p>	<p>INFORMASI PENYUSUN</p> <p>LAILY MUR AZIZAH</p> <p>Laily di Bopling, pada 18 November 2023 yang merupakan hari Minggu, saat ini sedang menemani pendidikan di Universitas Brawijaya 7000 Jember Agustus 2023. Pengalamannya pernah menulis puisi yang diterbitkan di majalah Kerasa tahun 2017. Kini ia sudah lupa tempat penemuannya. Beliau hanya ingin berbagi keajaiban "Koperwuz", ia mengembangkan unsur visual, cerita, dan materi pembelajaran diharapkan dengan komik ini dapat memberikan kontribusi positif dalam dunia pendidikan. Harapannya dalam membantu proses pembelajaran yang kreatif dan kontekstual.</p> <p>dr. @lailywuz</p>	<p>Capaian Pembelajaran</p> <p>Peserta didik dapat mengidentifikasi proses perubahan wujud zat dan perubahannya bentuk energi dalam kehidupan sehari-hari.</p> <p>Tujuan Pembelajaran</p> <p>1. Peserta didik dapat mengidentifikasi perubahan wujud zat padat, cair, dan gas (12)</p> <p>2. Peserta didik dapat mengartikan kembali perubahan wujud zat menjadi, membeku, menguap, menyublim, mengembun dan mengkristal (12)</p> <p>3. Peserta didik dapat mengartikan benda yang dialami dalam kehidupan sehari-hari termasuk perubahan wujud zat menjadi, mengesal, membeku, menguap, menyublim, mengembun dan mengkristal (12)</p> <p>4. Peserta didik dapat menyimpulkan bagaimana perubahan wujud zat dapat terjadi (12)</p>	<p>Petunjuk Penggunaan Komik</p> <p>1. Bacalah komik sesuai dengan halaman yang ada di setiap halaman komik.</p> <p>2. Diskusikan dan tulis untuk mencatat hal-hal penting.</p> <p>3. Jika sudah paham akan konsep atau sudah memahami akan konsep.</p> <p>4. Buatlah rangkai ulang yang menjelaskan perubahan wujud zat.</p> <p>5. Ceritakan kembali atau Amara yang terdapat di dalam komik atau diilustrasikan kembali guru.</p> <p>6. Praktikkan kembali konsep dan latihan yang yang telah diberikan oleh guru mengenai materi perubahan wujud zat.</p>
<p>Pengenalan Karakter</p> <p>1. Nama: Laily Mur Azizah</p> <p>2. Tempat: Bopling</p> <p>3. Pekerjaan: Guru</p> <p>4. Hobi: Menulis</p> <p>5. Pendidikan: Universitas Brawijaya</p> <p>6. Alamat: Jember</p> <p>7. Kontak: @lailywuz</p>	<p>1. Mencair: Es batu menjadi air.</p> <p>2. Membeku: Air menjadi es.</p> <p>3. Menguap: Air menjadi uap.</p> <p>4. Menyublim: Es menjadi uap.</p> <p>5. Mengembun: Uap menjadi air.</p> <p>6. Mengkristal: Air menjadi es.</p>	<p>1. Mencair: Es batu menjadi air.</p> <p>2. Membeku: Air menjadi es.</p> <p>3. Menguap: Air menjadi uap.</p> <p>4. Menyublim: Es menjadi uap.</p> <p>5. Mengembun: Uap menjadi air.</p> <p>6. Mengkristal: Air menjadi es.</p>	<p>Agar dapat memuat! Perubahan wujud zat terbagi menjadi 6 yaitu:</p> <ol style="list-style-type: none"> 1. Mencair 2. Membeku 3. Menguap 4. Menyublim 5. Mengembun 6. Mengkristal

3) Development

The third step was the development of the Koperwuz comic media, incorporating NoS elements, to be used by grade IV students at SDN Tarokan 4. Before being widely implemented, Koperwuz required validation by media and content



experts using standardized instruments. The media validation instrument covered appearance, usability, and content, while the content validation instrument assessed instructional aspects, content, and language appropriateness. Suggestions and comments from expert validators during validation served as the basis for revising the initial product. After revisions, the final product was re-tested, and if deemed feasible, the NoS-based Koperwuz media was considered ready for classroom use.

a) Media

Koperwuz is an educational comic designed to help students understand phase changes visually, through dialogue and contextual scenarios. It was developed as a full-color, printed comic (A5 size, 16 x 20 cm), consisting of 8 sheets (8 pages per sheet), printed on art paper. The comic included learning outcomes, objectives, usage instructions, and character introductions. The storyline depicted everyday situations relevant to phase changes, enabling students to connect scientific concepts to their experiences. Each type of phase change was explained sequentially, with examples and illustrations.

b) Validation Results

Media must be validated before classroom implementation to ensure that its content, design, and presentation align with instructional goals and student characteristics. Validation was conducted by content and media experts using a Likert-scale questionnaire. The results are as follows:

Table 11. Media Expert Validation Results

Aspect	Score
Media Validation	88%
Content Validation	100%

According to Riduwan (2015), a score of 81%–100% is categorized as “highly valid.” Based on this criterion, the Koperwuz media validation score was 88%, and the content validation score was 100%. Both were classified as highly valid and suitable for use.

4) Implementation

The implementation phase was crucial to determine the effectiveness of the media in improving student learning outcomes. Before classroom use, a practicality test was conducted to evaluate ease of use, attractiveness, and usefulness for both teachers and students. Practicality was assessed through questionnaires during both limited and wider trials. Results showed that the media was suitable for instructional use.

a) Product Practicality

Practicality was assessed to determine the appropriateness and usability of the media in supporting classroom instruction. The limited trial involved grade IV teachers and students at SDN Tarokan 4. The results are as follows:

Table 12. Teacher and Student Responses

Aspect	Score
Teacher Response	87%
Student Response	75%

According to Riduwan (2015), a score of 81%–100% is considered “highly practical.” The teacher response score of 87% indicates that Koperwuz is highly practical and suitable for broader classroom implementation. For students, a score of 75% indicates that the media is practical and appropriate for school use. After confirming practicality, the media was implemented in class on the topic of phase changes, involving active student participation facilitated by the teacher.

b) Product Effectiveness

Effectiveness testing assessed the impact of Koperwuz (with NoS content) on student learning outcomes, using a quantitative approach with pretests and posttests. The pretest measured prior knowledge, followed by instruction using the Koperwuz media, and finally, a posttest assessed learning gains. The effectiveness test involved 30 students. According to Sukarelawan *et al.* (2024:10), effectiveness was calculated using SPSS for Windows.

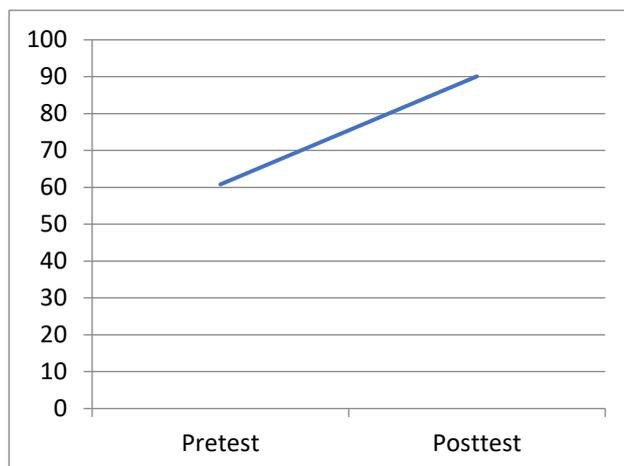


Figure 1. Pretest and Posttest Results

Table 13. N-Gain Test Results

N	Minimum	Maximum	Mean	Std. Deviation
30	0.58	1.00	0.7639	0.11114
	58.33	100.00	76.39%	11.11

Analysis showed an average N-Gain of 0.7639, which, according to Sukarelawan *et al.* (2024:10), falls into the "high" category. The N-Gain percentage was 76.39%, indicating that the media was effective in improving student learning outcomes. Additionally, teacher and student feedback provided supporting data to reinforce the conclusion of the media's effectiveness.

5) Evaluation

Validation by media and content experts confirmed that the Koperwuz instructional media met eligibility criteria without requiring revision. Expert assessments indicated that the aspects of appearance, content, and usability were excellent. Likewise, teacher and student responses via practicality questionnaires showed that Koperwuz was practical and suitable for classroom use. Therefore, no revisions were made at this stage, as neither the validators nor the initial users provided suggestions for improvement. Some obstacles during implementation included the limited number of printed media and insufficient instructional time, as teachers needed to explain the comic's content before students could read independently.

Discussion

The discussion of research findings covers the specifications, strengths, and weaknesses of the instructional media. Koperwuz, an acronym for "Komik Perubahan Wujud Zat" (Comic of Phase Changes in Matter), is an educational comic designed to help students understand the concept of phase changes in matter visually, dialogically, and contextually. According to Sudjana in Hakim (2017), comics are a form of cartoon that depicts characters and tells stories sequentially through images, arranged primarily for entertainment. Comics can be effective instructional media when designed according to students' needs and the subject matter (Budiarti & Haryanto, 2016). Koperwuz was developed as a full-color printed comic in A5 size (16 × 20 cm), consisting of 8 sheets (each sheet containing 8 pages). The language used is communicative and tailored to the cognitive level of fourth-grade students. The illustrations are engaging, with bright colors and expressive characters suited to the world of children. The comic's storyline reflects everyday situations relevant to the topic of phase changes in matter, enabling students to connect scientific concepts with their own experiences.

Koperwuz incorporates NoS (Nature of Science) elements, aiming to strengthen students' understanding of science concepts and the nature of scientific inquiry in real life (Dagher & Erduran, 2016). Each type of phase change is explained through a coherent and illustrative narrative. Structurally, the comic consists of three main sections: an introduction that includes learning objectives and character introductions; a main section that illustrates scientific phenomena; and a conclusion that summarizes the lesson (Indrawini *et al.*, 2017). Visuals in the comic serve as a communication tool to deliver messages and meanings imaginatively (Payanti, 2022).



The strengths of Koperwuz media include its ease of use without the need for additional tools, attractive comic design, concrete illustrations, simple and easily understood language, and contextual presentation of the material. However, Koperwuz also has some weaknesses, such as vulnerability to damage due to its printed format, high costs for color printing, and limitations to text and images without the ability to display movement or direct experiments. The effectiveness of instructional media is influenced by several factors, including the alignment of the media with learning objectives, student characteristics, and the quality of the media design—particularly its attractiveness and clarity. Additionally, the learning environment, appropriateness of the content, and student engagement in using the media play significant roles. Media that has been validated and proven practical by both teachers and students is more likely to be effective in the classroom. For future researchers, it is recommended to develop similar media for other science topics or different grade levels, and to consider creating digital versions to increase interactivity. This study has several limitations that should be acknowledged. First, the findings are context-specific, limited to fourth-grade students at a single elementary school, and therefore cannot be generalized to other schools or grade levels. Second, the practicality measurement relied on subjective questionnaires, which may be subject to bias from both teachers and students. These limitations provide a basis for future research to broaden the scope and employ more diverse measurement instruments.

Conclusion

Based on the research findings and discussion, it can be concluded that the validity of the Koperwuz instructional media, which is integrated with the Nature of Science (NoS), achieved an average score of 88%. Meanwhile, the validation results from content experts yielded a perfect score of 100%. According to these validation results, the media meets the “highly valid” criteria and is suitable for use in classroom instruction. The practicality of the Koperwuz instructional media, as measured by teacher responses, obtained an average score of 87%. Student responses to the use of Koperwuz were also positive, with an average score of 75%. The effectiveness of Koperwuz was analyzed through pretest and posttest results administered to students before and after using the media in learning activities. Based on the analysis, students’ learning outcomes improved, with an average pretest score of 60.8 and a posttest score of 90.1. The N-Gain calculation resulted in a score of 0.7639, which falls into the “high” category. The N-Gain percentage was 76.39%, indicating that the media is effective and suitable for improving the learning outcomes of fourth-grade students. From these conclusions, this research is expected to serve as a reference for teachers in selecting engaging instructional media that align with the characteristics of elementary students. Schools may also adopt similar media to enhance the quality of science education and improve student achievement. Future researchers are encouraged to develop similar media for other science topics or different grade levels, and to consider creating digital versions to increase interactivity.

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