

Energy Transformation Digital Comic as a Post-Pandemic Learning Recovery Effort in Fourth-Grade Elementary School

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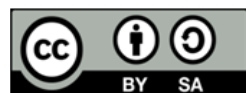
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ABSTRAK

Permasalahan learning loss akibat pandemi COVID-19 pada saat ini masih banyak terjadi di sekolah dasar. Hal ini berdampak pada hasil belajar IPAS pada siswa yang rendah. Penelitian ini bertujuan untuk mengembangkan media pembelajaran berupa komik digital sebagai upaya learning recovery pasca pandemi. Metode penelitian yang digunakan adalah metode penelitian R&D (Research and Development) dengan menggunakan model pengembangan Borg & Gall. Subjek penelitian ini yaitu ahli materi dan ahli media pembelajaran. Subjek uji coba penelitian ini yaitu uji coba skala kecil yang dilakukan oleh 9 siswa dengan menggunakan teknik purposive sampling dan guru. Subjek uji coba efektifitas produk sejumlah 34 siswa. Metode yang digunakan untuk mengumpulkan data yaitu observasi, wawancara, kuesioner, dan tes. Instrumen yang digunakan dalam mengumpulkan data yaitu lembar kuesioner dan soal tes. Teknik yang digunakan untuk menganalisis data yaitu analisis dekriptif kualitatif, kuantitatif, dan statistik inferensial. Hasil dari penelitian ini berupa media komik digital yang sudah melalui tahapan revisi serta mendapatkan nilai validasi tinggi dari ahli media dan ahli materi sehingga media ini dianggap sesuai dan dapat diterapkan dalam pembelajaran dan penelitian. Selain itu, perbedaan terlihat secara signifikan antara data pretest dan posttest setelah dilakukannya analisis skor N-Gain menunjukkan adanya peningkatan kemampuan belajar siswa berupa pemahaman materi dengan kategori tinggi. Disimpulkan bahwa komik digital yang dikembangkan dapat digunakan untuk menanggulangi learning loss di sekolah dasar..

ABSTRACT

The problem of learning loss due to the COVID-19 pandemic is currently still common in elementary schools. This has an impact on low science learning outcomes for students. This research aims to develop learning media in the form of digital comics as a post-pandemic learning recovery effort. The research method used is the R&D (Research and Development) research method using the Borg & Gall development model. The subjects of this research are material experts and learning media experts. The test subjects for this research were small-scale trials carried out by nine students using purposive sampling techniques and teachers. The test subjects for product effectiveness were 34 students. The methods used to collect data are observation, interviews, questionnaires, and tests. The instruments used to collect data were questionnaire sheets and test questions. The techniques used to analyze data are qualitative, quantitative, and inferential statistical descriptive analysis. The results of this research are digital comic media, which has gone through the revision stage and received high validation scores from media experts and material experts. This media is considered suitable and can be applied in learning and research. After analyzing the N-Gain scores, significant differences were also seen between the pre-test and post-test data, indicating increased students' learning abilities regarding understanding the material in the high category. It was concluded that the digital comics developed could be used to overcome learning loss in elementary schools.

1. INTRODUCTION

Quality education can help students understand learning materials more interestingly and enjoyably. Education can also help students improve their skills and knowledge (Saloviita, 2020; van den Heuvel et al., 2020; Yunaini et al., 2022). In early 2020, social distancing and lockdown policies led to school closures in many countries (Korkmaz & Toraman, 2020; Mpungose, 2021). As a result, online learning has

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become the single most effective way to use learning (Basri et al., 2021; Yuhastina et al., 2020; Zainul et al., 2020). Although learning activities are carried out online, they guarantee different results than learning offline / face-to-face. The pandemic has had a major negative impact on student learning. Many students experience difficulties and obstacles in adapting to the new online learning environment, including access to technology, an uncondusive learning environment, and a lack of social interaction with peers (Adi et al., 2021; Guariso & Björkman Nyqvist, 2023; G. A. Sari, 2020). Students' lack of experience with technology in education before the COVID-19 pandemic was a major cause of concern for teachers and students, impacting the development of students' literacy skills (Alsubaie, 2022; Kusuma, 2020; Sari et al., 2021). As a result, concerns about learning loss have emerged in many countries.

This is reinforced by previous research findings, which also stated that the impact of distance learning is a learning loss (Cerelia et al., 2021; Solihat et al., 2022). Other research also confirms that several factors influence learning loss in children, including the transition from distance learning to limited face-to-face learning (Muthmainnah & Rohmah, 2022; Widayarsi et al., 2022). Other studies also reveal that inadequate infrastructure and facilities in distance learning or limited face-to-face learning also cause learning loss in students (Engzell et al., 2021; Turner et al., 2020). Student motivation decreases due to long-distance learning and relatively short face-to-face time. Learning loss is a phenomenon that causes children to lose knowledge and skills (Cerelia et al., 2021; Solihat et al., 2022). Learning loss can occur due to a too long gap or a lack of interaction between teachers, educators, and students in the learning process. This can be caused by disrupting the direct face-to-face learning process (Donnelly & Patrinos, 2021; Muthmainnah & Rohmah, 2022; Widayarsi et al., 2022). In some cases, learning loss can have long-term impacts on students' futures, such as poor exam results, lack of skills needed for certain careers, and lack of preparation for higher education. This aspect of pandemic recovery will require additional time and attention to address teacher retention and avoid teacher shortages (Moscoviz & Evans, 2022; Sokal & Eblie Trudel, 2023).

Based on these problems, one way to overcome learning loss in students is to hold learning recovery. Learning recovery is important to help students regain learning abilities and academic skills lost during the pandemic. The recovery of students' academic abilities certainly varies in each region, but with the same goal: to return students to their academic path (Nugraha, 2022; Warsito et al., 2022). Learning recovery efforts can be done in various ways, such as using creative and interactive learning media, adjusting the curriculum and learning methods that are more appropriate to the current learning situation, and providing individual support and guidance to students. A new curriculum has emerged called the Merdeka Curriculum (Jamaludin et al., 2022; Rahayu et al., 2022). The Independent Curriculum with the concept of independent learning in elementary schools provides "freedom" for education implementers, especially teachers and school principals, in compiling, developing, and implementing a curriculum based on the potential and needs of students and schools (Evy Ramadina, 2021; Rahmadayanti & Hartoyo, 2022).

The Independent Curriculum was created to improve the standard of education in Indonesia. Students may find learning easier without feeling burdened by assignments if the independent curriculum is tailored to their needs and personality traits (Budiwati et al., 2023; Retnaningsih & Khairiyah, 2022). In this curriculum, teachers are expected to be the driving force in providing positive things to their students (Ainia, 2020; Waruwu et al., 2022). Teachers are also one of the keys to educational success because teachers have a central role in the learning process (Arviansyah & Shagena, 2022; Muhardini et al., 2023). The Merdeka curriculum is a restructuring of the national education system in Indonesia to encourage change and progress for the nation so that it can later be used to adapt to changes in the times (Muhardini et al., 2023; Yamin & Syahrir, 2020). In addition to curriculum changes made to address learning loss, it is also important for teachers to use learning media that can increase students' interest in learning.

One of the digital media that can reduce learning loss in students is the use of innovative digital-based media. One of the media that can be used to facilitate student learning is digital comics. Digital comics are one type of learning media in graphic form (Asnawi et al., 2023; Kanti et al., 2018; Wahyudin et al., 2020). Over the past few years, comics have become an increasingly visible and sought-after part of mainstream culture. Comics are images that tell stories and convey messages to readers (Sukmanasa et al., 2017; Syahmi et al., 2022; Wijaya et al., 2020). In addition, comics are said to be narrative images equipped with a combination of images and text and partly to emphasize the characteristics of all subjects that can enrich the narrative background, elements of form, body movement, and sound images (Ariestina & Haryanto, 2022; Supartayasa & Wibawa, 2022). Comics effectively convey learning content to students' knowledge because learning messages are delivered in an interesting, structured, clear, and enjoyable way.

Previous research findings also revealed that digital comics can significantly increase students' enthusiasm for learning (Pinatih et al., 2021; Sukmanasa et al., 2017). Other findings also revealed that digital comics can significantly improve student learning outcomes (Kanti et al., 2018; Supartayasa & Wibawa, 2022; Udayani et al., 2021). The use of digital comics can help reduce learning loss in students. However, there has yet to be a study on digital comics of energy transformation as an effort for post-

pandemic learning recovery in the fourth grade of elementary schools. The advantages of digital comic media that will be developed are the combination of attractive graphics from comics and the digitalization of learning to create digital comic learning media that can improve students' understanding skills in learning. In addition, the use of digital comic media is also considered to help efforts to restore students' learning abilities after the pandemic. Therefore, this study aims to develop digital comics of energy transformation for post-pandemic learning recovery in the fourth grade of elementary schools. The digital comics that will be developed will create innovative and effective learning media to improve students' learning abilities. This product is designed and presented not only as a result but also as an action that is expected to impact the recovery of students' learning abilities.

2. METHOD

The research method used is the R&D (Research and Development) research method using the Borg & Gall development model (Sugiyono, 2019). The main objective of R&D research is to produce high-quality products or innovations that can be applied in real practice. The main focus of this research is to develop digital comic learning media on energy transformation material by utilizing a combination of graphic design in the form of images and text. The development of this media was carried out through 10 stages, but the researcher limited it to the 8th stage, namely the trial use, due to time and cost constraints. So, the stages that the researcher used were potential and problems, data collection, product design, design validation, design revision, product trial, product revision, and trial use. The location of this research is at SDN Bantengmati 2.

The subjects of this study were material experts and learning media experts. The subjects of this study's trial were small-scale trials conducted by nine students from SDN Mijen 1 using purposive sampling techniques and teachers. The subjects of the product effectiveness trial were 34 students. Observation, interviews, questionnaires, and tests were used to collect data. The observation and interview methods were used to obtain data in the form of problems that occurred in the field and data in the form of learning outcomes of fourth-grade students at SDN Bantengmati 2. The questionnaire was used to collect data in the form of input and scores given by experts regarding the digital comic products developed. The test method collected data on student learning outcomes after using the digital comic products developed. The instruments used in collecting data were questionnaire sheets and test questions. The instrument grid used is presented in Table 1.

Table 1. Expert Instrument Grid for Learning Media

No.	Indicator	Score				
		5	4	3	2	1
1	Ease of operating commands in the media					
2	Clarity of reading text					
3	Harmony of text and images					
4	Accuracy of use of fonts and font sizes					
5	Color selection					
6	Media's ability to motivate students					
7	Media can be a source of individual, small-group, and class learning					
8	Balance of color composition					
9	Ease of media management					
10	Attractive graphic design					
11	Neatness of page layout					

The techniques used to analyze the data are qualitative, quantitative, and inferential statistical descriptive analysis. Qualitative descriptive analysis is used to process data from input provided by experts, teachers, and students regarding the digital comic on energy transformation. Quantitative descriptive analysis is used to analyze data from scores given by experts, teachers, and students regarding the digital comic on energy transformation. Inferential statistical analysis is used to analyze the effectiveness of the digital comic of energy transformation on student learning outcomes. The effectiveness test uses N-Gain analysis.

3. RESULT AND DISCUSSION

Result

This study uses the Borg and Gall model to develop a digital comic of energy transformation for post-pandemic learning recovery in the fourth grade of elementary school. The results of the study are as follows. First, potential and problems. In the initial stage, namely potential and problems, observations and interviews were carried out with fourth-grade teachers of SDN Bantengmati 2, Mijen District. The interview results identified problems with students' learning abilities in the Natural and Social Sciences subject of energy transformation material after the COVID-19 pandemic and the minimal use of learning media in teaching and learning activities due to limited facilities and infrastructure.

Second, data collection. At this stage, data collection was carried out by distributing questionnaires on teacher and student needs for the desired devices, media, methods, and learning models. From the results of the analysis of the data that had been collected, it was found that the delivery of material in teacher books and student books was limited. In addition, the use of learning media was minimal, so it could have been more interesting for students to learn. Third, product design. The next stage is product design. At this stage, product design was carried out in the form of digital comic learning media for energy transformation with the appropriateness of learning achievements and learning objectives to be achieved. This digital comic media was developed according to the characteristics of students by paying attention to graphic design (images), text, and storyline. The Canva application assisted media creation. The material and product design were entered into the Flipbook application. The final product produced is a digital comic accessed via Flipbook. The results of the development of the energy transformation digital comic are presented in Figure 1.



Figure 1. Results of the Development of the Energy Transformation Digital Comic

Fourth, design validation. At this stage, experts validate and evaluate the product for improvement before testing. The results of the assessment and evaluation by the validator are then used to revise the product being developed. The results of the data analysis show that the assessment carried out by the learning media expert is 81%, so the Digital Comic of Energy Transformation gets a valid qualification. The assessment results given by the learning material expert are 88%, so 81% of the Digital Comic of Energy Transformation get a valid qualification. The assessment results are presented in Table 2.

Table 2. Design Validation Values

Evaluation	Validation Index (%)	Information
Learning Media Expert	81	Valid
Learning Media Expert	88	Valid

The results of the descriptive analysis show that the media validation value by media experts and material validation by material experts are valid because they get a value above 80%, so they are included in the very feasible criteria. Fifth, design revision. This stage is a product assessed and evaluated by experts, after which it will be revised according to expert input. Suggestions given by media experts include changes to the font type. Material experts suggest adding a glossary and instructions for using the media. The assessment and evaluation by the validator are then used to revise the product being developed. After the Digital Comic of Energy Transformation, a product trial was conducted.

Sixth, product trial. The trial was conducted in class IV of SDN Mijen 1 using nine student samples. The sample selection was heterogeneous, with the division of 3 top-ranking students, three middle-ranking students, and three bottom-ranking students. The product trial was conducted by implementing learning by introducing the digital comic learning media of energy transformation accompanied by the class teacher. Then, after completing the learning, students and teachers were asked to fill out a questionnaire regarding the product. The results of the recapitulation of student and teacher response questionnaires are presented in Table 3.

Table 3. Results of Teacher and Student Responses to the Digital Comic Media Energy Transformation

Respondent	Evaluation (%)	Information
Teacher	96	Worthy
Students	82	Worthy

Table 3 shows the results of teacher and student responses to the digital comic learning media of energy transformation, which had very decent results because they scored more than 76%. Seventh, product revision. At this stage, product revisions were made based on input and suggestions given by teachers and students. The data analysis results showed no significant input from teachers and students, so a trial of use could be conducted. Eighth, namely, a trial of use. A large-scale trial was conducted in class IV of SDN Bantengmati 2 with 17 students. The research technique applied by the researcher was pre-experimental with a one-group pretest-posttest design research model. This research design uses a pre-test before giving treatment and a post-test after giving treatment. The results are used as a measurement value for product effectiveness. Statistical testing using the normality test is used to see the results of the distribution of student scores. The results of the normality test of student scores in the small-scale trial are presented in Table 4.

Table 4. Results of the Large-Scale Normality Test

Group	Shapiro-Wilk			
	Statistic	df	Sig.	
Score	Pretest	0.950	17	0.460
	Posttest	0.943	17	0.350

Based on Table 4, the results of the normality test calculation show a sig value of 0.46 > 0.05 for the pre-test value and a sig value of 0.350 > 0.05 for the post-test value, so it can be said that the pre-test and post-test value data are normally distributed. The average student learning outcomes increased by a difference of 24.12. The data interprets students' pre-test and post-test results in grade IV of SDN Bantengmati 2. The researcher conducted an N-Gain analysis to determine the average pre-test and post-test increase category. The results of the N-gain analysis were 0.57. It was concluded that the grades of fourth-grade students of SDN Bantengmati 2 increased with a moderate category. This average increase shows that using digital comic learning media for energy transformation in science learning in grade four of SDN Bantengmati 2, Mijen District, Demak Regency, has improved student learning outcomes.

Discussion

The results of the data analysis show that the digital comic learning media of energy transformation in Natural and Social Sciences learning is feasible to be used in learning. This is due to several factors. First, digital comic learning of energy transformation is feasible because it can improve student learning outcomes. E-comic media is a type of computer-based multimedia learning media that refers to content that uses digital technology to present information through various media, including images, sound, video, and text (Artha et al., 2020; Asnawi et al., 2023; Taufiq et al., 2020). E-book applications allow users to access material in a format similar to a printed book. Still, they can also be accessed with additional interactive elements such as panels and text balloons (Artha et al., 2020; Setyaningsih & Canda Sakti, 2020; Siregar et al., 2019). After the trial use, it was concluded that the digital comic media of energy transformation was able to help achieve learning objectives. Implementing creative, effective, and enjoyable learning optimally is inseparable from the characteristics of child development, learning principles, and curriculum that meet children's needs (Abdurrohman et al., 2020; Indriasih et al., 2020). The use of digital comics is effective because it can provide a positive contribution to the learning process. Students find it easier to understand the learning material presented in digital comics, which impacts increasing learning outcomes (Indriasih et al., 2020; Udayani et al., 2021).

Second, the digital comic of energy transformation is suitable for learning because it can increase students' enthusiasm for learning. The media aims to attract students' attention and increase their interest in learning the materials available (Asnawi et al., 2023; Kanti et al., 2018; Wahyudin et al., 2020). Improving students' learning abilities will be the main goal of creating this learning media. In addition, comics help students achieve their desired learning goals (Aeni & Yusupa, 2018; Wajdi et al., 2022). Comic books provide simple stories that are easy to grasp and understand, so they are very popular with both children and adults (Artha et al., 2020; Muhaimin et al., 2023). Comic media plays a role in inspiring students and triggering their interest in learning. The stories and content of the material contained in the comics support students in connecting the concept of the material with everyday life (Ahdad & Khairaty, 2023; Syahmi et al., 2022). Learning media captures the attention of students and teachers, and understanding the meaning of the teaching material becomes clearer and easier for students to understand (Abdurrohmim et al., 2020; Indriasih et al., 2020; Wijaya et al., 2020). The use of appropriate media can increase students' motivation to learn. Digital comic media makes learning interesting and fun and can reduce misunderstandings and ambiguity.

Third, digital comics of energy transformation are suitable for learning because they can improve the fun learning atmosphere. Learning media is one of the tools teachers use so that learning activities take place effectively (Ahdad & Khairaty, 2023; Astutik et al., 2021; Syahmi et al., 2022). Digital comics provide information, are intermediaries from teachers to students, thus motivating and enabling them to make meaningful progress during the learning process, or are used as liaisons (Hidayah et al., 2017; Rohmanurmeta & Dewi, 2019). Using digital comics in learning can positively impact student engagement and academic achievement and create a more engaging learning atmosphere (Aeni & Yusupa, 2018; Sukmanasa et al., 2017). In practice, students prefer to learn by using teaching materials that show visuals, non-standard language, and simple explanations of the material. The effect of using digital comics in education is to accelerate the teaching and learning process of students and teachers and improve the learning atmosphere to be more enjoyable.

Previous research findings also revealed that digital comics that received very good qualifications could be used in learning (Asnawi et al., 2023; Riwanto & Wulandari, 2018). Other studies also confirm that well-designed digital comics effectively increase students' motivation, learning outcomes, and learning atmosphere (Aeni & Yusupa, 2018; Handayani, 2021; Komikesari et al., 2020; Wicaksana et al., 2019). It is concluded that students in learning can use the developed digital comic of energy transformation. This study implies that the use of digital comics in learning can have a positive impact on student engagement and academic achievement. The study results indicate that using digital comics can improve learning outcomes in students. The results of this study are expected to contribute to the development of innovative learning media to overcome the impact of learning loss after the COVID-19 pandemic, especially in understanding energy transformation material at the elementary school level.

4. CONCLUSION

The study results indicate that the digital comic learning media of energy transformation is highly feasible based on expert validation and teacher and student responses. The results of the N-gain test also show that the digital comics developed effectively improve students' understanding of the material of energy transformation. It is concluded that the digital comic learning media of energy transformation in science learning is feasible for learning. This learning media can make learning easier for students and increase their motivation to learn Natural and Social Sciences.

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