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Development of Magnetic Digital Comics in Science Learning to Improve Student Learning Outcomes in Elementary Schools

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Abstract: This study aims to develop digital comics for learning magnetism in learning Science in Elementary Schools. This type of research is development research, which refers to the Four-D. The location of this research is at Kota Tengah 80 Public Elementary School, Bulangu Timur 1 Public Elementary School, and Telaga Biru 1 Public Elementary School. The results of the study show that digital comic magnets developed for science learning in elementary schools: (1) are categorized as valid and feasible; (2) Practically used, this is indicated by the very good response from students with a percentage of 90% in the limited trial class and 93.75% in the extended trial class. The implementation of learning in the limited trial class obtained an average percentage of 90.91%, while in the extended trial class it was 96.15%; (3) Effectiveness, indicated by good student activity with a percentage of 82% in both limited trial classes and extended trial classes, as well as student learning outcomes that are in very good criteria. Based on this, the digital comics magnet that has been developed is stated to be valid, practical and effective, so that it can be used in the science learning process in class V of elementary school.

Keywords: Digital comics; Learning outcomes; Magnets

Introduction

Information technology advancements are currently having an effect on a number of aspects of life, including education. Since information technology systems have already been used in the learning process, the government and other relevant institutions may use this as an alternative or solution to address the existing situations in the educational sector, for instance, by combining multimedia into the educational process. The use of multimedia in the learning process has been carried out previously and shows that the use of multimedia can have a positive impact on learning.

Various learning multimedia have been developed to support the implementation of learning, including the use of augmented reality-based multimedia that can improve students' scientific literacy during (Ahied et al., 2020), as well as the use of instructional video media in elementary school learning which is effectively used in learning, because make it easier for educators to teach material and make it easier for students to understand learning material (Ridha et al., 2021). Therefore, teachers are challenged to be creative and adaptive, in the sense of being able to adapt to the demands of the development of science and technology (Yustina et al., 2020).

The use of multimedia in learning, of course, must also consider the developmental characteristics of students. Multimedia that is good for use in elementary schools is in accordance with the stage of student development. In general, the behavior of elementary school children is still very active to play, happy with interesting pictures and colors, and wanting to do new things. Therefore, science learning multimedia innovations that have many interesting pictures, colors, and easy-to-understand presentations of material can

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stimulate students' minds to prefer science learning than other subject. One of them is multimedia which contains comics that are liked by elementary school children.

According to Buchori et al. (2015) comics contain messages through illustrations and written texts that contain various themes that are often based on the experiences of children's daily lives, so the use of comics is one way to make learning more fun (Susanti et al., 2016). In general, children like illustration pictures, such as those in comics, this can be seen where most of the fifth graders enjoy reading comics as a means of entertainment. It is easier for children to remember characters and stories when they are presented in comic form. Empirically students tend to like reading books that have pictures, colors and are visualized in cartoon or realistic form (Daryanto, 2016). In science learning, comics can be used to present various natural events concretely for students, which is why comics are considered easier to understand and more interesting to use for elementary school students than textbooks used in learning (Aslamiyah et al., 2017).

Children of grade V are in the stage of concrete operational thinking where at this stage students can carry out concrete operations, students can also reason logically as far as that reasoning can be applied to specific or concrete examples in their daily lives (Santrock, 2012). Therefore, the use of comics learning media is very appropriate for students at the elementary school level to be able to improve learning outcomes and student responses in participating in the science learning process, as the results of research by Ambaryani et al. (2017) on the material for Changes in the Physical Environment which shows that comics can improve cognitive learning outcomes for elementary students. In addition, according to Yuliariatiningsih (2017) comics can also increase multiple intelligences for elementary students, then according to Widyawati et al. (2015) which states that the use of comics can increase students' learning motivation which will certainly have an impact on improving student learning outcomes. This is supported by Suparmi (2018) who stated that the use of comics in learning can improve student learning outcomes.

The development of Android-based e-comic learning media can be a way to help the learning process in the classroom given that the use of comics media has a favorable impact on learning and is supported by the habits of today's students who like to use smartphones. The use of e-comics in the learning process in elementary schools is efficient and successful, according to research by Taufik et al (2021). This result is supported by Kasih et al. (2022), stated that e-comic is efficiently used in the learning process.

Therefore, the purpose of this research is to develop an android-based science e-comic of magnetic force material, in this case using the Smart App Creator application. By using this application, comics that have been developed can be accessed.

Method

The method of this research is using Research and development which refers to the four-D model design according to Thiagarajan (1974) which consists of four stages, namely defining, designing, developing and disseminating, where the trial phase was carried out at Telaga Biru 1 Public Elementary School, West Pentadio Village, Gorontalo Regency, Gorontalo Province of fifth grade in (fifth grade) of the 2017/2018 academic year. The limited trial was conducted on 10 students, while the expanded trial was conducted of fifth grade in B (fifth grade) at Telaga Biru 1 Public Elementary School.

Akker (1999) and Nieveen (1999) stated that in research and development model, quality criteria are needed, namely validity, practicality, and effectiveness. Therefore, the instruments used include instruments to measure the validity, practicality, and effectiveness as described below.

To get validity data from comics learning media, the instrument used is an expert validation sheet. Validation was carried out by two physics learning experts and two learning media experts. The validation of the Magnetic Style comic learning media contains several assessment parameters, namely in terms of construction, content and language, readability and appearance. Each expert will put a tick in the column score on a scale of 1-4 available on the expert validation sheet. The practicality data of comics media in science learning includes data on student responses to the use of magnetic style comics learning media and the implementation of learning using magnetic style comics learning media.

This practicality data was collected using the following instruments: (a) Questionnaire to determine student responses to the use of Magnetic Style comics based on Smart App Creator (b) Observation sheets of learning implementation were used in the learning process. Observers will put a tick (√) on the YES option for each syntax that is implemented and will put a tick (√) on the NO option if the syntax is not implemented.

The effectiveness of learning media includes data on student learning activities and data on student learning outcomes. This data was obtained by using: (a) Student activity observation sheets to obtain data on student learning activities, and (b) Learning Outcomes Test to obtain data on student learning outcomes.

Analysis of the data in this research includes the analysis of validity, practicality, and effectiveness as described below.

Validity Analysis

The validation results of each expert are calculated and averaged using the equation (1).

$$Average\ Score = \frac{Score\ V_1 + Score\ V_2 + Score\ V_3 + Score\ V_4}{4} \quad (1)$$

Description:
V_1 = Validator 1
V_2 = Validator 2
V_3 = Validator 3
V_4 = Validator 4

The average validation results are then converted to the validation criteria shown in Table 1. Table 1 presents the scoring criteria for the assessment which was adapted from Arikunto (2017).

Table 1. Eligibility Validation Score Criteria

Score	Assessment Criteria
4	Very good/very feasible/very suitable
3	Good/feasible/Attractive/Appropriate
2	Not good/not feasible/less attractive/not suitable
1	Not good/not suitable/not interesting/not suitable
0	Very unfavorable/very inappropriate/very unattractive/very unsuitable

Based on the table above, the comic media based on the Smart app Creator in learning can be used if it meets the criteria of being feasible or very feasible based on expert judgment.

Practical Analysis

The steps for analyzing the student response questionnaire are: (a) Consists of a scale of 1-4, for positive statements: strongly disagree = 1, disagree = 2, agree = 3, strongly agree = 4, and for negative statements: strongly disagree = 4, disagree = 3, agree = 2, strongly agree = 1; (b) Counting the total number of students who answered in each aspect from a scale of 4 to 1; and (c) Calculate the total percentage of students (%) who answered in each scale (from 4 to 1) for all aspects.

Assessment of student responses and implementation of learning is done by matching the results of the average total score given with the following criteria in Table 2 (Sukardi, 2013).

Table 2. Criteria for Learning Implementation

Value Range (%)	Interpretation
86 – 100	Very Good
76 – 85	Good
66 - 75	Enough
56 – 65	Less
0 – 55	Very Less

Based on the description above, if the results of filling out the questionnaire state a positive response, then the learning media is said to be practical. For the implementation of the learning process using science comics learning media is said to be practical if the learning syntax using comics media in science learning is included in the good or very good category.

Effectiveness Analysis

Assessment of student activities and student learning outcomes is carried out by matching the results of the average total score obtained with the criteria in Table 2. The use of science comics learning media is said to be effective if the activities and student learning outcomes are in good or very good criteria.

Result and Discussion

The development of this magnet digital comic begins with the definition stage (define), the results obtained at this stage are data on basic problems faced by teachers or students, where the main problem encountered is the lack of learning media that can be used as student learning resources on the low student learning outcomes in science learning. Another problem is that students really like spending time with smartphones to play social media or online games.

At the definition stage, it was also found that all students have smartphones and in classroom learning, the teacher occasionally gives students the opportunity to search learning materials through google. In addition, in the learning process teachers more often use power point to explain the material to students. Given that all students have smartphones, then the use of digital comics in the learning process can certainly support the science learning process the use of smartphones in the learning process can certainly support the science learning process.

Several literature studies show that the use of android-based smartphones in learning can improve students' academic performance Resti et al. (2016). Moreover, the use of comics in science learning provides great benefits for students, both in increasing student motivation and character (Widyawati et al., 2015), as well as in improving student learning outcomes (Taufik et al., 2021).

Therefore, this research will develop a digital comic magnet that can be used by students in the learning process. This digital comic development produces a product in the form of an apk extension file that can be opened on an Android smartphone after installing it first. The advantage of this product is that internet data is only needed when installing the application, then this application can be used anytime anywhere without using internet data.

Furthermore, at the design stage, digital science learning comics were developed by taking into account the results at the definition stage. This comic contains material about the meaning of magnets, the poles of a magnet, the properties of magnets, objects that can be attracted by magnets, and objects that cannot be attracted by magnets. Furthermore, the comic is entered into the Smart App Creator application, so that it can be used by students both via Android cellphones and laptops or computers. In the following, some comic views are given in the applications that have been developed.

Figure 1. Magnetic digital comics

The comics that have been compiled are then validated by science learning experts and learning media experts. After the comics are compiled and validated, research activities are continued with the preparation and validation of learning tools that will be used to implement comics media in the learning process.

The validation of science comics learning media along with other learning tools contains several assessment parameters, namely in terms of construction, content and language, readability and appearance. Validation results obtained in the form of qualitative suggestions and assessment sheets. Qualitative suggestions are used as a reference for revising the science comics learning media and other learning tools. After being revised, the experts filled out the assessment sheet with the following assessment results in Table 3.

Table 3. Results of Learning Device Validation

Learning Media	Assessment Category
Comics media	Very feasible
Syllabus	Very feasible
Lesson plan	Very feasible
Student worksheet	Very feasible
Teaching materials	Feasible
Learning outcomes test	Feasible

Based on Table 3, it can be seen that, in general, the learning media for science comics and other learning tools are in the very feasible category, this is because in terms of construction, content and language, the readability and appearance of the comics developed are in the very good category, so they are feasible to use in the learning process.

Next for the practical aspect, the practicality of magnetic digital comics developed is determined by student responses obtained through student response questionnaires and the implementation of learning. In a limited trial, students' responses to the use of magnetic digital comics were obtained in Figure 2.

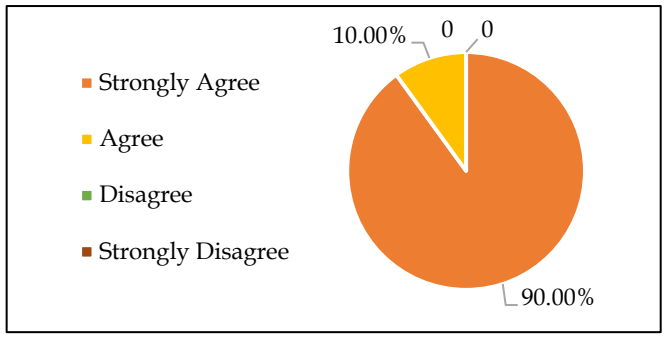

Figure 2. Students' responses to the use of magnetic digital comics

Based on Figure 2, it can be seen that 90% of students strongly agree and 10% agree to use magnetic style comics in the science learning process. As a result, the magnetic digital comic can be used on a wider scale. In the extensive trial, students' responses to the use of magnetic digital comics can be seen in Figure 3.

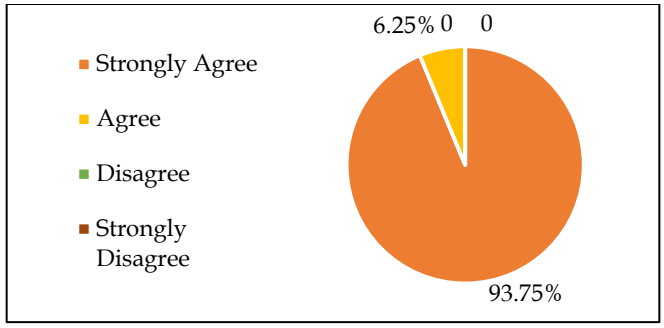

Figure 3. Students' responses to the use of magnetic digital comics

Based on Figure 3, it can be seen that 93.75% of students strongly agree and another 6.25% agree to use magnetic style comics in the science learning process. This shows that comics can improve student responses in the learning process, in this case increasing students' interest in learning during the learning process. This is because the comics used in the learning process are interesting, thereby increasing the attention, interest, pleasure, and involvement of students in the learning process.

These results are in line with the results of research by Devy et al. (2016) which stated that students are motivated to learn by using comics used in learning, thereby increasing students' analytical thinking skills and scientific attitudes. Another study conducted by Ani et al. (2015) showed that comics can increase students' learning motivation.

In terms of process implementation, in the limited trial class the average percentage of learning implementation using Magnetic Style comics was 90.91%, while in the expanded trial class it was 96.15%, as shown in Figure 4.

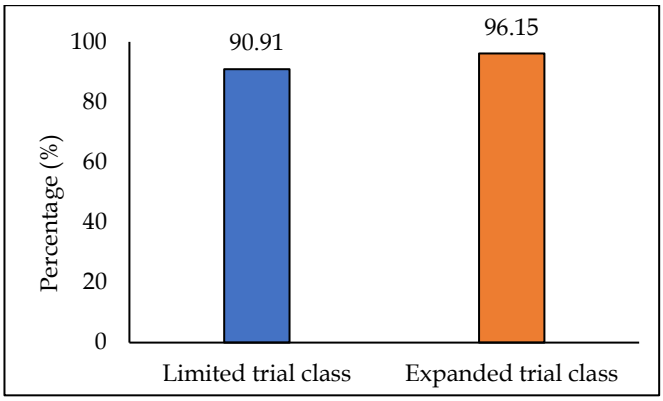

Figure 4. Percentage of implementation of the learning process

Figure 4 shows that the implementation of learning using Magnetic Style comics is in very good criteria, where based on observations it can be seen that every syntax in the learning process using comics can work well apart from that, through the use of comics learning messages can be conveyed because comics are a medium communication in the form of narratives that are easily understood by children. As research by Fedotova et al., (2015) which states that comics are a good medium for communicating information in the learning process. These results are in line with the research of Negrete (2013) which stated that comics are a medium in the form of a good narrative to communicate certain information.

Based on the results of student responses and the implementation of the learning process, the learning media for science comics with magnetic force material that has been developed can be declared to meet the practicality criteria to be used and applied in the learning process. The third aspect is effectiveness. The effectiveness of the magnetic digital comics developed is determined by student activities during the learning process and student learning outcomes which include attitude assessment, cognitive assessment and student skill assessment.

The following is a diagram of the percentage of student activity in the learning process in the limited trial class and the expanded trial class can be seen in Figure 5.

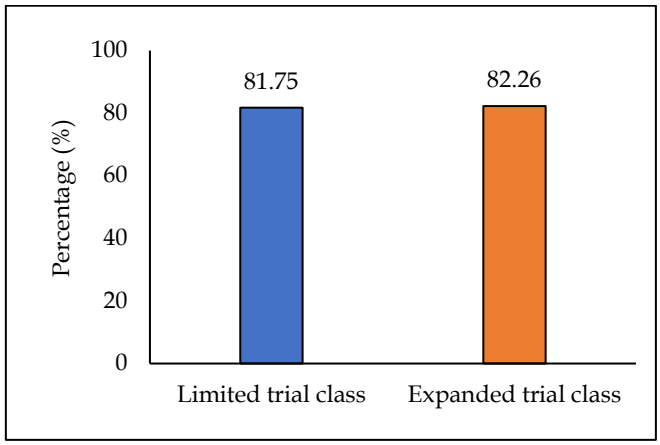

Figure 5. Percentage of student activity

Based on the results shown in Figure 5, it can be seen that student learning activities are in good criteria, where the activities observed consist of seven aspects, namely listening, reading, writing, asking, answering, solving questions, and concluding. This shows that Magnetic Digital comics can be used in the science learning process, because through the use of comics students' learning activities are in good criteria, where based on observations during the online learning process, it shows that all activities expected to be carried out by students are observed during the learning process. This result is supported by the research of Wicaksono et al. (2020) which states that comics are effective in increasing student activity and learning outcomes.

Furthermore, for student learning outcomes in the limited trial class can be seen in Figure 6.

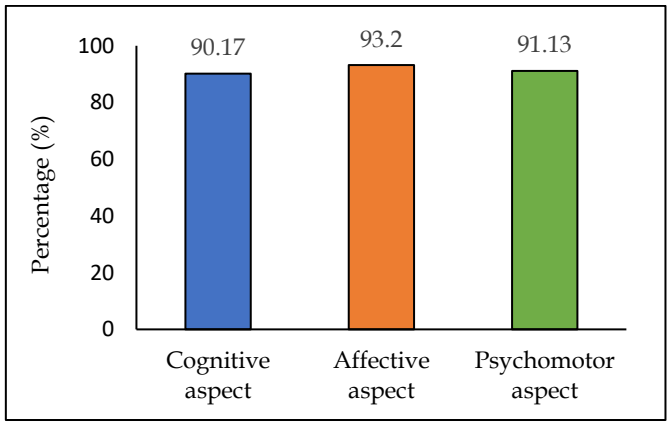

Figure 6. Students' learning outcomes in limited trial class

Furthermore, for student learning outcomes in the expanded trial class, it can be seen in Figure 7.

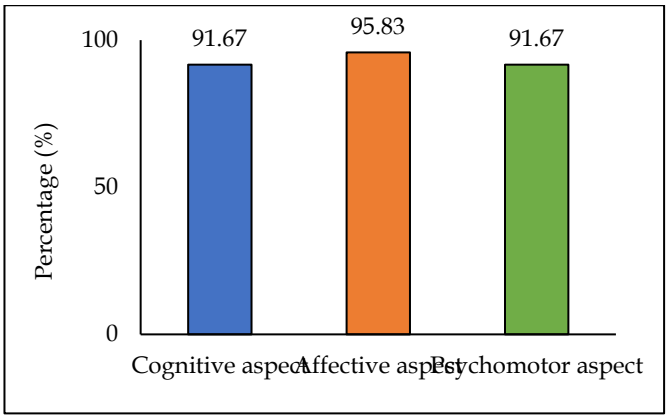

Figure 7. Students' learning outcomes in expanded trial class

The results of the limited trial in Figure 6 show that the classical learning outcomes reach the minimum completeness criteria, then the expanded trial results in Figure 7 above show that the classical learning outcomes reach the minimum completeness criteria. These results indicate that magnetic style comics are effective for improving student learning outcomes, because the use of comics learning media can improve student responses and learning activities which have an impact on improving student learning outcomes.

These results are in line with the results of research by Margiyati et al. (2016) that science comics can be used as learning media that can increase student activity and learning outcomes. This is supported by Ernawati (2016), Fatimah et al. (2014) who argue that comics learning media can improve student learning outcomes, although according to Hadi et al. (2015) that some comics can only be used by students with good cognitive abilities. However, according to Yulianti et al. (2016) comics can improve the characteristics and cognitive achievement of elementary school students by using the inquiry learning model. This means that the use of appropriate learning models certainly plays a role in maximizing the use of comics in improving student learning outcomes, as stated by Rosyida (2018) that the use of comics based on the CTL learning model can improve elementary school student learning outcomes.

By adjusting the current development and conditions of students, of course, the use of e-comics in science learning will be more practical and effective, as the findings of Pinatih et al. (2021) which stated that digital comics or e-comic media are suitable for use in science learning and can improve students' mastery of concepts (Mutiaramses et al., 2022). Based on the description above, the Magnetic Style comic is appropriate to be used in the science learning process because it can increase students' interest and motivation to learn, as well as students' activities and learning outcomes.

Conclusion

The results showed that the Magnetic Digital Comics that were developed were: (1) in the proper category; (2) Practical to use, this is indicated by the very good response from students and the percentage of implementation of learning, both in the limited trial class and in the expanded trial class, which is categorized as very good; (3) Effective, indicated by very good student activity, as well as student learning outcomes that are in very good criteria, for the limited trial class and the extended trial. As a result, the Magnetic Digital Comics that have been developed are said to be valid, practical and effective, so that they can be used in the science learning process of fifth grade in Elementary School.

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