

Development of Teaching Materials for Science Courses Based on Digital Comic on Temperature, Heat, and Expansion Materials for Class Vii Smpit Al Kahfi, Bogor Regency

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Abstract: This study aims to 1) determine the procedure for developing digital comic-based science teaching materials on temperature, heat, and expansion grade VII materials, 2) determine the feasibility of digital comic-based science teaching materials on temperature, heat, and expansion grade VII materials, 3) find out the effectiveness of science teaching materials based on digital comics on the material of temperature, heat, and expansion for class VII. This study uses research and development methods (Research and Development). The results of this study are 1) the development of digital comic-based teaching materials using the ADDIE model (analyze, design, development, implementation, evaluation). This product is based on an application that can be installed on a computer or device, making it easy to use anywhere. The material presented is temperature, heat, and expansion. In the development of digital comics teaching materials, family characters (mother and children) are used and are equipped with images that match the storyline. There are also materials, practice questions, and evaluations that are tailored to the curriculum of the driving school. 2) the feasibility of teaching materials is obtained from the results of the validation of the material experts who show a value of 80% which means that it enters the criteria very valid/feasible, while the linguist shows a value of 96% which means that this product is very valid/feasible, while the results from media and learning design experts by 76% and 79% which means valid/feasible. 3) The average pretest obtained in the field trial was 59, while the posttest was 74. Based on the normality test, that the significance value was $0.2 > 0.05$ that the resulting data were normally distributed. Based on the hypothesis test data.

Keywords: Teaching materials, Digital comics, Research and development

Preliminary

Background

Learning during a pandemic is certainly very different from normal conditions. Health conditions are the main thing at this time. So the curriculum is designed with these different conditions. There is an alternative distance learning so that the educational process continues. Meanwhile, there is a special policy for pesantren-based schools that pesantren are allowed to hold face-to-face learning. However, with parental consent. In face-to-face learning, the allocation of learning time is reduced from 40 minutes/meeting to 35 minutes/meeting. This of course has an impact on one of the subjects that has a lot of material content, namely science

Many learning media have been applied to facilitate student learning. These media include power points, videos, pictures, and props. Learning methods that have been applied to science subjects have also varied such as active learning, cooperative learning, problem based learning. However, both the media and learning methods that have been applied turn out to have science subject material whose results are below the minimum completeness achievement. These materials are temperature, heat, and expansion.

Students have difficulty in understanding science material. Especially if the material is in the form of story questions. This is due to the lack of literacy of students. Less interest in learning. Students also feel bored quickly when learning science.

Not to mention, there are still positive cases of Covid, both teachers and students. Therefore, it is necessary to have an alternative after returning to face-to-face learning. In connection with the above problems, one alternative is the innovation of teaching materials. Through teaching materials, the teacher does not convey too much material. Students can explore the material more deeply. In addition, the existence of these teaching materials also supports individual learning. So that an independent attitude emerges and is able to think critically.

The use of teaching materials at SMPIT Al Kahfi uses textbooks from private publishers and textbooks from the government. Based on observations, it was found that the learning materials were not provided with important things. The sample questions in the book are also less varied. This results in student learning outcomes below the minimum completeness.

Science subjects are one of the complex subjects, because they cover all living things (humans, animals and plants), inanimate objects, and environmental conditions. In connection with the above, the current urgency includes the need for ease of learning after the decision to allow face-to-face learning, the need to foster a literacy culture, the need for innovation in learning media to attract students' interest in learning, and take advantage of the convenience of technology for learning. One of the things that can be used is digital comic-based teaching materials. The advantage of this comic-based teaching material is that the presentation of the material uses a series of cartoon characters that play a storyline that is adapted to the science subject matter. Comics as a visual communication medium that has the power to convey information in a popular and easy to understand manner. This is possible because of the combination of images and writing in a storyline so that it is easily absorbed. Especially if the comics are digital-based, students will easily access them and attract interest in learning.

Based on the above, this research will develop teaching materials based on digital comics. It is hoped that the use of digital comic-based teaching materials can make science learning effective and attract students' reading interest. So that students are motivated to learn science and learning outcomes increase.

Identification of Problems

During science learning, several problems were found, namely what are the difficulties of students in understanding science lessons? How to raise students' interest in reading, especially for science subjects? Do science textbooks attract students' interest in learning? How can students keep up with material left behind during self-isolation? How are teaching materials that can be used after face-to-face learning is carried out again? How to use technology to facilitate learning science?

Formulation of the Problem

Based on the background, identification, and limitation of the problems mentioned above, the formulation of the problem is proposed as follows:

1. How is the development of science teaching materials based on digital comics on temperature, heat, and expansion materials?
2. How is the feasibility of digital comic-based science teaching materials on temperature, heat, and expansion materials?
3. How is the effectiveness of using comic-based science teaching materials on temperature, heat, and expansion materials?

Theory Review

Teaching Materials

One important element in learning is the existence of teaching materials to facilitate learning. The Director General of Primary and Secondary Education (2008) defines teaching materials as a set of materials that are

systematically arranged so as to create an environment/atmosphere that allows students to learn. Teaching materials as part of learning resources.

A. Types of Teaching Materials

Majid (Nana, 2020) teaching materials are grouped into four types, including:

- a. Printed teaching materials
Printed teaching materials are teaching materials whose manufacturing process is through printing, for example books, modules, worksheets, photos, etc.
- b. Audio teaching materials
Audio teaching materials are teaching materials in the form of audio, including cassettes, radios, audio CDs.
- c. Audio Visual Teaching Materials
Teaching materials are teaching materials that can be seen and heard. For example CDs, Videos, and movies.
- d. Interactive teaching materials
Teaching materials that encourage students to be active. Example: interactive CD.
- e. Principles of teaching materials
(Nana, 2020) Some principles that need to be considered when choosing teaching materials are:
 - Principle of relevance
Learning materials must be relevant to basic competency and competition standards.
 - Principle of consistency
If there are four basic competencies that must be mastered, then the teaching materials to be taught must have four types.
 - Sufficiency Principle
The material taught must be adequate or sufficient to help students achieve their learning goals (mastering competency standards and basic competencies).

Comic

(Smaldino SE, 2014) Cartoons are line drawings in the form of rough caricatures of real things, humans, animals, and fictional events published in various print media such as newspapers, magazines, and textbooks. In its presentation, cartoons are easy to read and attract interest at all ages. Cartoons can also help the reader's intelligence. The benefits of comics in education (Akcanca, 2020) The benefits of using comics in the education and training process include:

- Make learning easier
- Improving motivational for the class
- Improving academic performance
- Having fun while learning
- Promoting interest in the classroom
- Imagination development

Based on the description above, it is concluded that the benefits of comics in the world of education include conveying scientific information visually, making learning easier, increasing learning motivation, improving learning outcomes, learning more fun, increasing student interest in learning, being able to develop imagination. (Akcanca, 2020) The elements that make up comics include

- Character, Character is the main element in comics. The stories told in comics are processed through the characters.
- Language, Krashen explained that the language used in comics acts as a bridge between everyday language and academic language, which is considered to have a positive effect on learning success (Akcanca, 2020).
- Time, Time in comics is unlimited. (Akcanca, 2020) Comics inform readers about the time they are in.
- Themes, Comics present themes to readers with an uninterrupted illustration method. The theme can serve to reveal the details of the message that you want to give to the reader.
- Graphic elements

Illustrations in comics have a powerful effect in keeping the story alive for the reader. Maintaining a balance between text and images in comics and the fact that writing does not dominate the story is important and must be considered.

Science Subjects

Natural Sciences helps students to grow their curiosity about the phenomena of the universe. The main focus to be achieved from integrated science learning is not on how much material content can be absorbed by students, but on how competent students are in inquiry skills, namely observing, asking questions, asking hypotheses, selecting and managing information, planning and implementing actions and self-reflection on the learning process experienced.

In the school's operational curriculum (the driving school curriculum), learning is carried out based on phases. For junior high school entering phase D, which means that the learning achievement is that students are able to measure the amount of temperature caused by the heat energy given, as well as being able to distinguish insulators and conductors of heat.

Research Methodology

Research purposes

This study aims to 1. determine the procedure for developing digital comic-based science teaching materials on temperature, heat, and expansion grade VII materials 2. determine the feasibility of digital comic-based science teaching materials on temperature, heat, and expansion grade VII materials 3. determine the effectiveness of materials teach science based on digital comics on the material of temperature, heat, and expansion for class VI. Leave one blank line after each heading and two blank lines before each heading. (Exception: leave one line between consecutive headings.) Please margin all headings to the left. Leave one blank line after each heading and two blank lines before each heading. (Exception: leave one line between consecutive headings.) Please margin all headings to the left.

Research Time and Place

Research Time and Place

The time of this research was carried out for three months, namely from September to July November 2021. The research was carried out at SMPIT Al Kahfi Bogor.

Research methods

This study uses research and development methods (Research and Development). Sells and Richey in (Haviz, 2013) explain that development research is defined as a systematic study of the process of designing, developing, evaluating programs and learning products, and meeting the criteria for internal consistency and effectiveness of using the program or product. (Putra, 2011) also stated that the Research and Development method has goals including innovation, finding novelty, effectiveness, productivity, and quality.

Data collection technique

The data in this study used several data collection methods, including:

- 1) Questionnaire
- 2) Interview
- 3) Documentation

Journal writing in research methodology should contain Research Objectives, Time and Place = Research, Research Methods, and Data Collection Techniques.

Research Result

Based on the results of student questionnaires regarding learning difficulties and science learning outcomes, it is known that students feel bored quickly in receiving science lessons, students also need more time to understand science subjects, and interest in learning science is also still lacking.

Steps for Development of Science Teaching Materials Based on Digital Comics with the ADDIE model.

No	Karakteristik Kebutuhan	Temuan	Solusi
1.	Kebutuhan peserta didik	<ol style="list-style-type: none"> 1. Peserta didik kurang minat belajar IPA 2. Peserta didik kesulitan dalam memahami materi pelajaran IPA 3. Peserta didik membutuhkan waktu yang lama dalam memahami materi IPA 4. Peserta didik mudah bosan ketika belajar IPA 	Diperlukan media yang menarik, penuh gambar, aktivitas yang bervariasi, dan fleksibel dalam penggunaannya.
2.	Kebutuhan Media	<ol style="list-style-type: none"> 1. Media yang belum sesuai karakteristik peserta didik 2. Sumber belajar masih terbatas 	Bahan ajar berbasis komik digital

Based on the explanation above, it can be seen that students want media that does not make them bored, interesting media, and varied activities. One solution is the provision of digital comics teaching materials. These teaching materials allow the active role of students in learning and technology-based in accordance with the times and the needs of 4.0. Teaching materials are needed in the learning process. So that researchers need to know how to select and design teaching materials according to the material and needs of students. So that the teaching materials developed can really make learning effective. At this stage, researchers select and design teaching materials through the needs of teaching materials. The purpose of this analysis is to help researchers plan and implement and follow up on learning activities that will be managed by the teacher. The following are the steps for analyzing the needs of teaching materials:



Picture 1. Analysis of Learning Material Needs

Explanation of the image above:

1) Studying the applicable curriculum Before the researcher designed the teaching materials, the researcher conducted a review of documents related to the applicable curriculum at 61 SMPIT Al Kahfi. It was found that, grade VII applied the driving school curriculum, while for grades VIII and IX used the 2013 curriculum. Based on the results of interviews with teachers, it is known that the material considered difficult by students in semester 1 is temperature, heat, and expansion. The sub-material that is difficult to understand is the part of calculating heat in the form of story questions. Based on these, then an analysis is carried out related to learning outcomes that are in accordance with the curriculum at the driving school. The achievements of junior high school science learning in phase D are: Students are able to measure the amount of temperature caused by the heat energy given, as well as distinguish insulators and heat conductors.

2) Determine the competence of students. The learning objectives to be achieved in this lesson are to understand the concept of temperature correctly, understand the concept of heat correctly, describe the difference between temperature and heat based on case examples with confidence, use the formula to calculate the amount of heat of an object in story problems correctly, understand the concept expansion correctly, identify the expansion in everyday life with confidence.

3) Select and determine the material to be presented. Next, the researcher determines the material to be developed in the teaching materials, to find out the researchers conducted interviews with science subject teachers.

4) Selecting and determining the teaching materials developed. The selection of teaching materials is adjusted to the objectives to be achieved, existing conditions, and limitations. Based on the results of the interview, it was found that in fact several learning media, such as videos, ppt, pictures, had been presented during the lesson. However, the material difficulties still arise. In addition, students are easily bored when learning science. So that the idea of digital comic-based teaching materials emerged. The general characteristics of SMPIT Al Kahfi related to this research include learning science using teaching materials from a private publisher. However, the material presented is not short and clear. The condition of students was less interested in reading books. Low literacy causes the ability to understand the material is also low. In addition, books from the government are considered to be lacking in variety of questions. Meanwhile, in the use of learning media, teachers have used videos, pictures, and teaching aids to facilitate learning. The curriculum used for class VII is the driving school curriculum.

Based on the above, it is necessary to develop science teaching materials so that learning is more interesting and effective. The development of science teaching materials based on Digital Comics uses the ADDIE development model (analyze, design, development, implementation, evaluation). At the analysis stage, based on the results of interviews with teachers, it was found that students had difficulty learning science, especially about calculations. Not to mention the time available is not proportional to the scope of the material being studied. So that students need a lot of time to understand the problem. Students are also easily bored when learning science and interest in learning science is also lacking. So we need a product that can be a source of their learning which is certainly in accordance with the characteristics of students. The solution is the provision of teaching materials. This is expressed (Nana, 2020) that teaching materials can improve the learning process to be more effective. Teaching materials as a set of materials and resources that can help teachers and students. The selection of digital comic-based teaching materials is based on studying the applicable curriculum, namely the driving school curriculum, determining student competencies according to science learning achievements, selecting and determining the material to be presented, namely temperature, heat, and expansion, selecting and determining teaching materials developed according to the characteristics learners.

At the design stage, the researcher designed the learning design. Seventh grade students of SMPIT Al Kahfi mostly come from the upper middle class, the learning style is also more visual than auditory, and kinesthetic learning styles. Visual learning styles are 38%, auditory 27%, and kinesthetic 35%. The learning objectives consist of 6 equipped with the expected attitudes, namely independent and critical reasoning. The choice of method is the inquiry method. This method was chosen because it is able to grow the activeness of students (Sanjaya: 2006). The media used are science teaching materials based on digital comics that have been declared feasible by expert lecturers. The material presented is the chapter on temperature, heat, and expansion according to the results of interviews with teachers. Teaching materials are provided in the form of links that are distributed to students. Students use a computer laboratory with stable internet capacity. Student activities are reading, asking questions, trying practice questions, and discussing. Evaluation is carried out to determine student learning outcomes.

Furthermore, the design of teaching materials includes the creation of storyboards and digital comic scripts. The composition of digital comics in outline is 1) cover page, 2) table of contents, 3) instructions for use, 4) learning outcomes and learning objectives, 5) sub-materials, 6) practice questions, 7) evaluation, 8) about the author. There are three characters chosen, namely a mother, the first child named Alim, and the second child named Putra. In the development stage, the comics are made on the Medibang and CorelDraw applications, while in compiling the comics using Canva. At this stage is also the selection of fonts, colors are very important. Once compiled, validation is carried out by material experts, media experts, learning design experts, and language experts. Validation is carried out to determine the feasibility of teaching materials.

This is done by using a comparative hypothesis test between two different variables, namely the ability of students before using digital comics, and students who have used digital comics. Stages of Development of Science Teaching Materials based on digital comics:

1) Recreating comics, In making comic illustrations using medibngpaint and coreldraw. The concept of the story has been prepared by the researcher in the form of storyboard and digital comic scripts. After the results were completed, the researchers compiled teaching materials using Canva. The preparation is in accordance with the storyboard that has been made. Here are the steps for preparing teaching materials:
materials:

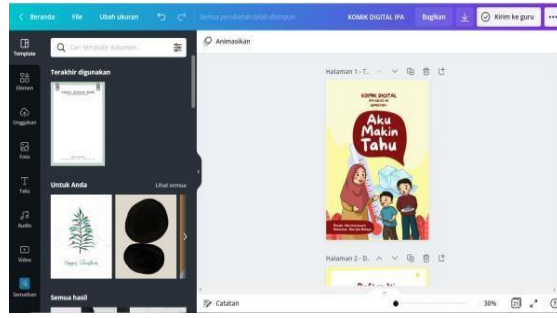


Figure 1. Paper size selection

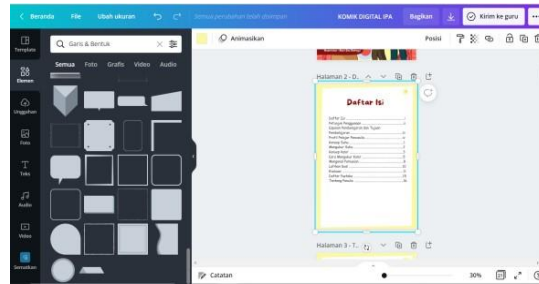


Figure 2. Background Selection

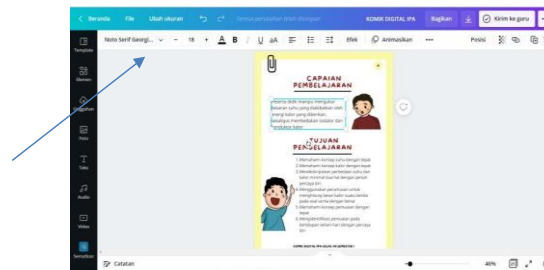


Figure 3. Font and size selection

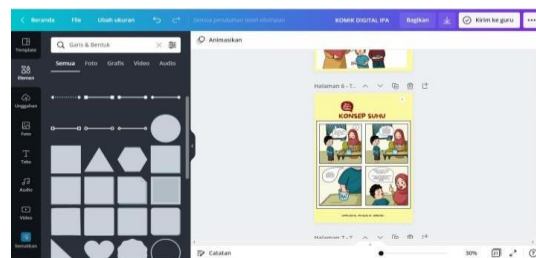


Figure 4. Page Numbering

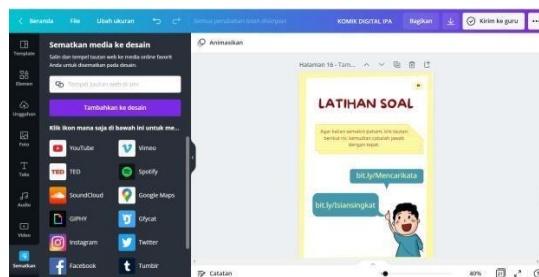


Figure 5. Making Links to Practice Questions

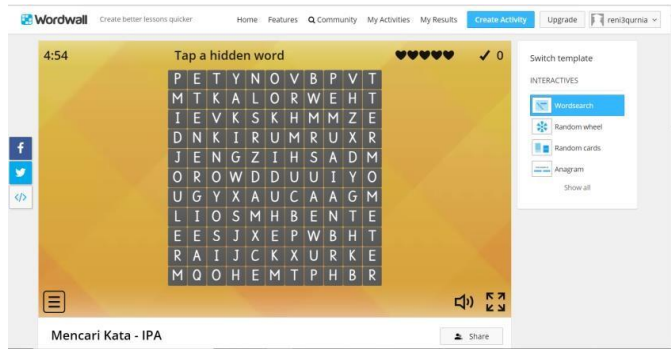


Figure 6. Preparation of Word Search Questions

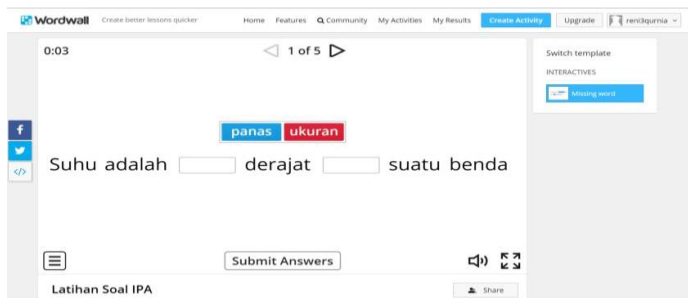


Figure 7. Compilation of Short Fields

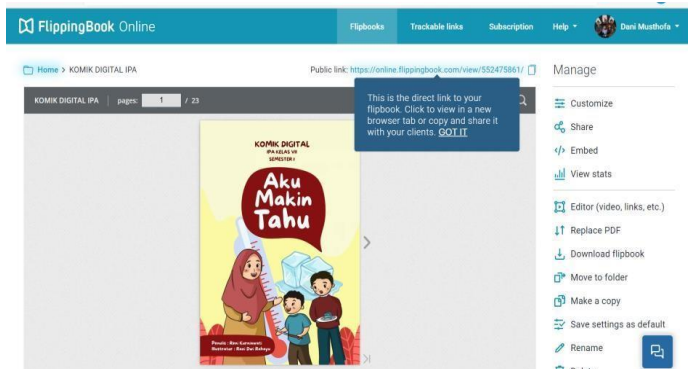


Figure 8. Digitization

Development of Digital Comic-Based Science Teaching Materials

General characteristics of SMPIT Al Kahfi related to this research include learning science using teaching materials from a private publisher. However, the material presented is not short and clear. The condition of students was less interested in reading books. Low literacy causes the ability to understand the material is also low. In addition, books from the government are considered to be lacking in variety of questions. Meanwhile, in the use of learning media, teachers have used videos, pictures, and teaching aids to facilitate learning. The curriculum used for class VII is the driving school curriculum. Based on the above, it is necessary to develop science teaching materials so that learning is more interesting and effective. The development of science teaching materials based on Digital Comics uses the ADDIE development model (analyze, design, development, implementation,

Then, an evaluation is also carried out to determine the response of teachers and students to products that are already feasible. The following are the results of the percentage of teacher responses to digital comic-based teaching materials:

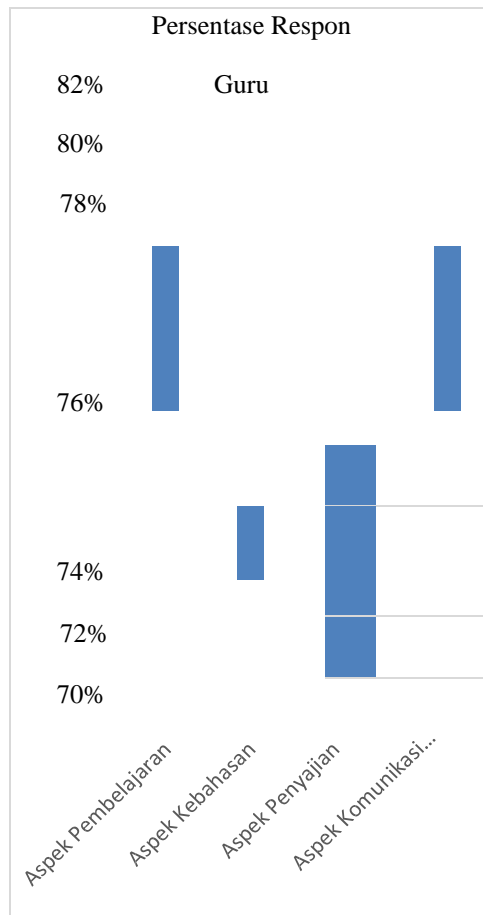


Figure 9. Percentage of Teacher Responses

The teacher's response to science teaching materials based on digital comics with a total score of 75, while the maximum score is 96. So the average (in percent) is 78%. If it is converted to a linkert scale, it is found that this product is attractive. The results of the responses of class VII students of SMPIT Al Kahfi Bogor in the form of a questionnaire with 10 indicators, namely:



Figure 10. Percentage of Student Responses

Based on the data above, it can be concluded that the attractiveness of digital comics teaching materials in the linkert scale is above 80%, which means it is categorized as very attractive as in the following explanation:

Table 1. Product Attractiveness

Presentase (100%)	Kriteria
80-100	Sangat Menarik
60-79	Menarik
40-59	Kurang Menarik
0-39	Tidak Menarik

Feasibility of Digital Comic-Based Science Teaching Materials

The feasibility of science teaching materials based on digital comics for class VII semester 1 was obtained from the validation results from material experts, media experts, learning design experts, and language experts. The following is an explanation of the validation

Percentage of the feasibility of teaching materials from the material aspect includes content and linguistic aspects. The following are the results of the analysis of the material expert review data:

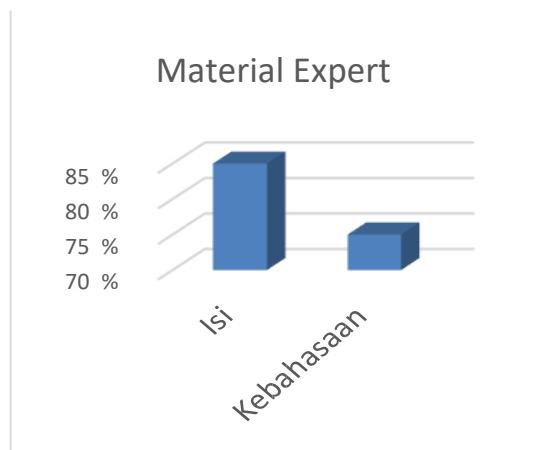


Figure 11. Material Expert Validation Results

Based on the data above, the average validation from material experts in the content aspect is 85%, that the material is in accordance with the learning objectives, the truth of the concept of the material, the material is presented in sequence, there are practice questions, interesting pictures. (Widodo, CS & Jasmadi, 2008) explains that teaching materials must contain learning objectives.

Conclusions and Suggestions

Conclusion

1. Development of digital comic-based teaching materials The development of science-based digital comics teaching materials is based on needs analysis and learning. This teaching material is a medium for delivering teacher messages to students. Comics are works of art pictorial that uses the character of a character in acting stories with interesting language aim to entertain and help intelligence for readers. As for the development of digital comic-based teaching materials using

ADDIE model (analyze, design, development, implementation, evaluation) This product is based on an application that can be installed on a computer or device, making it easy to use anywhere. The material

presented is temperature, heat, and expansion. In the development of digital comics teaching materials, family characters (mother and children) are used and are equipped with beautiful images according to the storyline. There are also materials, practice questions, and evaluations that are adapted to the curriculum of the driving school. 2. Feasibility of digital comic-based teaching materials. The development of this product was validated by material experts, media experts, learning design experts, and language experts. The results of the material expert validation show a value of 80% which means that it is very valid/feasible, while the linguist shows a value of 96% which means that this product is very valid/feasible, while the results from media and learning design experts are 76% and 79% which means valid/worthy. Therefore, this product was partially revised before being tested on students. 3. The effectiveness of digital comic-based teaching materials. At this trial stage, the inquiry learning model was designed. Field trials were conducted on students of class VII.8 with a random sampling technique totaling 27 respondents.

To determine the effectiveness of student learning outcomes, it is necessary to test the initial ability and final ability. So that before using this product, students do a pretest to determine their initial ability. After that, students were treated with the inquiry method. Students read digital comics teaching materials and the question and answer process to the teacher. After learning ends, students do the posttest. The average pretest obtained in the field trial was 59, while the posttest was 74. Based on the normality test, the significance value was $0.2 > 0.05$. Therefore, the assumptions or requirements for normality have been met or it can be said that the resulting data students do the pretest to determine the initial ability. After that, students were treated with the inquiry method. Students read digital comics teaching materials and the question and answer process to the teacher. After learning ends, students do the posttest. The average pretest obtained in the field trial was 59, while the posttest was 74. Based on the normality test, the significance value was $0.2 > 0.05$. Therefore, the assumptions or requirements for normality have been met or it can be said that the resulting data students do the pretest to determine the initial ability. After that, students were treated with the inquiry method. Students read digital comics teaching materials and the question and answer process to the teacher. After learning ends, students do the posttest. The average pretest obtained in the field trial was 59, while the posttest was 74. Based on the normality test, the significance value was $0.2 > 0.05$. Therefore, the assumptions or requirements for normality have been met or it can be said that the resulting data. The average pretest obtained in the field trial was 59, while the posttest was 74. Based on the normality test, the significance value was $0.2 > 0.05$. Therefore, the assumptions or requirements for normality have been met or it can be said that the resulting data normally distributed. Based on the hypothesis test data, it can be seen that the significance value is $0.000 < 0.05$, it can be concluded that there is real difference. This means that H_0 is rejected, that there is a significant difference between science learning outcomes in pretest and posttest data.

Suggestion

Based on these conclusions, some suggestions from researchers include 1. Aspects of utilization a. Teachers can streamline and streamline the science learning process, both online and offline. b. This product is expected to be applied to students with low cognitive abilities, so that they can improve learning outcomes. 2. Dimensional suggestions This digital comic product was developed to streamline science learning, especially on the concepts of temperature, heat, and expansion, as well as how to measure heat, which is packaged with attractive illustrations and can be applied independently by students. So it is suggested that it can be produced and used as teaching materials for science learning. 3. Suggestions for further research development a. It is hoped that activities on digital comics teaching materials need to be further developed.

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