



Kabes Puppy Learning Media (Pythagorean Proving Puzzle) for Mathematics Learning Pythagorean Material

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Abstract— This study aims to describe learning media to facilitate students in constructing an understanding of the Pythagorean theorem. This study describes a learning media product in the form of a puzzle called Puppy (Pythagorean Proving Puzzle). Puppy is a puzzle proving the Pythagorean theorem on the Pythagorean theorem material for grade VIII students in junior high school. This media is different from the others because it is made from environmentally friendly materials that are easily found in the surrounding environment and can also be made by students themselves. This research uses a qualitative approach that uses narrative data and aims to describe a medium that can be used in learning mathematics using Pythagorean material as an innovative learning method. Puppy is packaged in an interactive animation form that is equipped with an evaluation of the understanding of the Pythagorean theorem so that it allows students to carry out individual evaluations of competency achievements related to the Pythagorean theorem. The structure of the material in Puppy consists of an explanation of the elements of a right triangle, an animation of the discovery of the Pythagorean theorem formula, and the application of this formula to right triangles. to find out the feasibility of a test conducted by media experts and material experts and also conducted on students.

Keywords— , Learning Media, Mathematic, Puzzles

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I. INTRODUCTION

Learning mathematics is basically learning to think or learning to solve problems. When studying mathematics, students need to be allowed to investigate and organize tangible objects before they can use symbols they already know in the abstract (Aggraini dkk., 2015). Learning mathematics cannot be separated from teaching concepts. The concept is not taken for granted but constructed. This is because learning entails accepting and constructing the concepts learned. To construct them through their interactions with objects, phenomena, experiences, and environment (Mas`ud, 2017). According to most students, mathematics is included in one of the subjects, which is a difficult subject. As a result, when many students are about to receive a mathematics lesson, their enthusiasm for learning appears to have vanished. As a result, the lessons given by the teacher in class will not be absorbed by students (Rifai, 2017).

Learning mathematics, which is often considered difficult, students' difficulties in learning mathematics are caused by its abstract nature and require the ability to think logically and sequentially (Noviani, 2019). Events that are often experienced in the field of education; namely the low learning outcomes of students in mathematics, are due, in part, to the limited use of conventional learning and learning media (Surur, 2021). The learning that takes place is still dominated by traditional learning, which causes students to be less motivated in learning mathematics, particularly learning mathematics that is driven by a collection of formulas in textbooks that force them to understand it (Surur, 2022).

Every concept in mathematics is related to another. In addition, a concept can be a prerequisite for other concepts (Hada dkk., 2021). Mastery of a concept is needed to learn other concepts. One of the concepts in mathematics is the Pythagorean theorem. The Pythagorean theorem is taught formally for the first time to Grade VIII students of SMP/MTs semester 1, using the Pythagorean theorem to determine the length of the sides of a right triangle and solving problems on plane figures related to the theorem of Pythagoras.

The Pythagorean theorem states that in every right triangle, the square of the length of the hypotenuse is equal to the sum of the squares of the lengths of the sides of the triangle (Ramda, 2017). Some of the mistakes that students often make are using the Pythagorean theorem to find an edge by adding or subtracting, and if subtracting, which one must be subtracted. One of the reasons for this is that students are not allowed to find the formula, so their memory of the formula is not optimal. Students will know the formula only from listening to the teacher's explanation or reading in books. Students are not given the opportunity to directly demonstrate.

Eddgar Dale's theory says that the lowest level of memorization is reading (only 10%), while hearing words, seeing pictures, seeing demonstrations, and participating in sequential discussions have a minimum of 20%, 30%, 50%, and 70% (Hernowo, 2015). When students do real-life activities, they can achieve 90% memory retention. The highest level is doing the real thing (Mas`ud Rifai, 2020).

Therefore, it is necessary to develop appropriate learning media as a medium for learning the Pythagorean theorem so that abstract concepts can be presented in real terms, easily accepted by students, and understood. One of the media that can be used to prove the Pythagorean theorem geometrically is puzzle media. The Pythagorean theorem can be used to prove that the square of the hypotenuse is equal to the sum of the squares of the other sides (Mas`ud, 2017), by approximating the area of a square with the length of the sides of a right triangle. The result of our discussion for the Pythagorean Theorem learning medium is Kabes Puppy, using used cardboard to make a Pythagorean puzzle. This learning media is not only flexible for the students, meaning they can learn while playing; educators are also given the convenience of making their own media by utilizing objects around them at an affordable cost (Ambar Sri Lestari, 2014).

The use of teaching media can help achieve learning success. The Danim emphasized that research results have proven the effectiveness of using tools or media in the teaching and learning process in the classroom, especially in terms of increasing student achievement. On the other hand, the limited media used in class is thought to

be one of the causes of the poor quality of student learning (Mahnun, 2012).

Learning media, according to Musfiqon, are tools, both physical and non-physical, that are deliberately used as intermediaries between teachers and students in understanding learning material so that it is more effective and efficient and so that learning material is more quickly accepted by students as a whole and attracts students' interest in further learning (Amrina dkk., 2021, 2022; Lumbantoruan dkk., 2022). For example, one of the materials in mathematics that can be made into learning media is the material for proving the Pythagorean theorem.

The Pythagorean theorem states that in every right triangle, the square of the length of the hypotenuse is equal to the sum of the squares of the lengths of the sides. This theorem was discovered by Pythagoras von Samos, a Greek mathematician who lived in the sixth century AD and had the opportunity to deepen his knowledge in Babylon. This theorem appeared around 4000 years ago, when the Babylonians and Chinese realized that a triangle with sides of 3, 4, and 5 units of length makes up a right triangle. You can use the Pythagorean theorem to determine the length of one side of a right triangle if the lengths of the other two sides are known. The proof of the Pythagorean theorem by approximating the area of a square with the length of the sides of the square corresponding to the sides of a right triangle can be used to prove that the square of the hypotenuse is equal to the sum of the squares of the other sides of a right triangle (Setyadi & Pangestu, 2020).

II. RESULT AND DISCUSSION

A. Media Characteristics, Roles, and Relations

1. Characteristics

a. Fixative property

Kabes Puphy is a medium that has fixative properties. This media can be used at any time and can store, preserve, and reconstruct an event or object. It can also record objects that occur at a certain time so that they can be immortalized, rearranged, and then produced.

b. Manipulatives of Property

The transformation of an event or object is possible because the media has manipulative characteristics. Kabes Puphy is a learning medium that can take days but can be presented to students in two or three minutes using the time-lapse recording technique.

c. Distributive property

Kabes Puphy is a learning medium that allows an object to be transformed through space while simultaneously being presented to a large number of students with relatively the same experiential stimulus regarding the incident. This medium can also be produced repeatedly and repeatedly used (Arsyad, 2003).

2. Role

The media has a role in learning activities; maybe so far, the media has only been considered a tool, but the media can also be used as an independent instructor or as self-instruction, meaning that in general, the media is used as a direct support for educators. In addition, adequate learning media can help improve the quality of learning. For example, Learning media uses Kabes Puphy; this media can play the following roles:

a. *Provide* a common experience.

By equating the perceptions of all students, it will also help equate student experiences because all students in the class use the media that the teacher has delivered..

b. *Clarify* the presentation of messages and information.

This is the most important thing the media should do because the media should clarify the information or messages already available in the learning book. For example, here we use Kabes Puphy's media to clarify material about the Pythagorean theorem. With this, students will be clearer about the Pythagorean theorem material that is already available in the book.

c. *Overcoming* sensory limitations
With a limited understanding of the material to prove the Pythagorean theorem available in the book, the Kabes Puppy media was created with the aim of being a medium to help overcome limitations on understanding.

d. Increase and direct *attention*.
Using learning media that is unique and interesting, will make students more interested in the media presented by the teacher and can make the attention and focus of all students focus on the media delivered by the teacher. So that the teacher's material can be adequately conveyed (Miftah, 2013).

3. The relationship between media and mathematics material

Learning mathematics is learning to think or learning to solve problems. According to Dodge and Colker, mathematics is the ability to form relationships and become thoughts. When learning mathematics, students must be allowed to investigate and organize concrete objects before using the symbols they already know in the abstract. Every concept in mathematics is related to another. In addition, a concept can be a prerequisite for other concepts. Therefore, mastery of a concept is needed to learn different concepts, including Pythagoras.

The Pythagorean theorem states that in every right triangle, the square of the length of the hypotenuse is equal to the sum of the squares of the lengths of the sides of the triangle. This theorem was discovered by Pythagoras von Samos, a Greek mathematician who lived in the sixth century AD and had the opportunity to deepen his knowledge in Babylon.

One of the media that can be used to present a geometric proof of the Pythagorean theorem is a media puzzle. The proof of the Pythagorean theorem by approximating the area of a square with the side lengths of the square corresponding to the sides of a right triangle can be used to prove that the square of the hypotenuse is equal to the sum of the squares of the other sides of a

right triangle. According to Patmodewo, the word puzzle comes from English, which means puzzle or disassembly. A media puzzle is a simple game that is played by disassembling pairs. That way, students can disassemble the puzzle pieces in the two squares and arrange them so that they can fill a square with a side length equal to the hypotenuse.

B. *Steps for Making Learning Media*

1. Tools and Materials

Making this media using materials that are environmentally friendly and easy to obtain in the surrounding environment. The materials needed include used cardboard, colored manila paper, marker pens, colored markers, pens, glue, and other additional materials as decorations. As for the tools needed, namely: scissors, a ruler, and a cutter.

2. Steps for Making Pythagorean Puzzles

a. The first step is to prepare the materials and tools to be used. Materials can be obtained by buying, taking, or borrowing if possible. You can choose the color of the manila paper according to your taste; here we use white as the puzzle container, black for the triangle, green for the square size resulting from the height of the triangle, and red for the square formed for the triangular base.

b. The second step, Make a large rectangular image on the used cardboard using a ruler and pen with a square size of 50 cm x 50 cm, then cut it using a cutter according to the square line, which will later be used as a puzzle container. Make two identical square pieces of cardboard, 50 cm by 50 cm in size, because one will be used as a puzzle mold and the other as a puzzle container.

c. The third step is to draw using a pen and ruler to form a flat shape that will be made into a puzzle pattern on cardboard that has been cut into a square, namely a triangle with a base of 16 cm, height of 12 cm, and slanted side of 20 cm. With the sides of the

- triangle made in a square shape, which means the high side of the triangle will be formed with a square measuring 12 cm x 12 cm, the base side will be formed with a square with a size of 16 cm x 16 cm, and the hypotenuse of the triangle will be formed with a square with a size of 20 cm x 20 cm, Cut the pattern using a cutter according to the wake lines that have been made.
- d. The fourth step, Coat the top of the cardboard as a coating, but don't cover the cardboard that has been cut and the bottom of the puzzle container cardboard as a cover with white manila paper and adhesive glue so that it can be perfectly coated on the cardboard as the base color layer, and also coat and cover the lower part of the puzzle, then glue the two cardboard boxes that have been covered with manila paper with adhesive glue.
 - e. The fifth step is to make a large triangular shape with a base size of 16 cm, a height of 12 cm, and a hypotenuse of 20 cm, which will be placed in the middle of the puzzle as a proof, and small squares measuring 4 cm x 4 cm of 25 pieces as the contents of the puzzle. proof, using a ruler and pen. Use scissors or a cutter to cut. From step number 3, you don't need to bother with the cut anymore to make a new small square shape, but you can still use the previous shape; it's just that you need to make a line with the help of a pen and ruler with a size of 4 cm x 4 cm and then cut with a cutter following the line pattern made using a cutter or scissors.
 - f. Step six: Cover the triangular and square pieces using colored manila paper and adhesive glue in the color you want. with provisions for 16 squares and 9 squares, each using manila paper of a different color. Here, we covered the triangles with black, 16 squares with red manila paper, and 9 squares with green manila paper. Then trim the edges of the triangular and square shapes using scissors so that they are easy to arrange when put together in a puzzle.
 - g. Seventh step: glue the triangle in the middle of the puzzle using adhesive glue so that it doesn't move when the contents of the square puzzle are attached. And don't forget to mark the sides of the triangle using a marker.
 - h. Eighth step, Give the title or name of the puzzle on the top of the blank puzzle using a black marker. You can also add a little decoration to the puzzle container to make it look even more appealing. Here are decorations made by making colorful lines using colored markers.
 - i. The last step is to arrange the contents of the square-shaped puzzle in the puzzle container that matches its size. Namely, red on the medium part, namely a, and green on the small part, namely b.

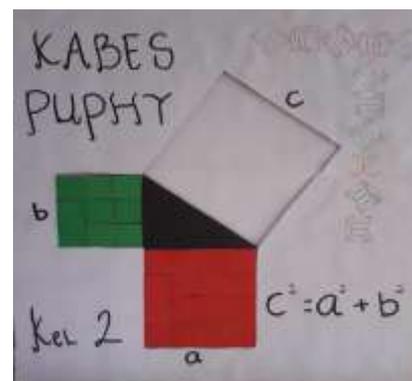


Fig. 1: Kabes PuppY Media

Thus, God willing, the puppy kabes that have been made can be used as a medium for learning mathematics, especially for grade 8 junior high school on Pythagorean theorem material.

C. Procedures for Media Use

Learning mathematics is learning to think or learning to solve problems. Every mathematical concept is related to another. When learning mathematics, students need to be allowed to investigate and organize concrete objects before they can use the symbols they already know in the abstract.

In addition, a concept can be a prerequisite for other concepts. Mastery of a concept is needed to learn other concepts; one of the mathematical concepts is the Pythagorean theorem. The Pythagorean theorem states that in any right triangle, the square of the length of the hypotenuse is equal to the sum of the squares of the lengths of the other sides.

In research at Salatiga Junior High School, it was revealed that students often make mistakes using the Pythagorean theorem. One of the reasons for this is that students are not allowed to find that the formula is not optimal; they only know the formula from listening to the teacher's explanation or reading about it in books but are not allowed to prove it directly.

Listening to words, seeing pictures, seeing demonstrations, and participating in discussions each have a value of 20%, 30%, 50%, and 70%. The greatest memory gain when students do real things can reach 90%. The highest level is achieved by doing real things; therefore, in student learning, it is necessary to provide opportunities for students to be able to find out the origin of the Pythagorean theorem formula. Learning media is a tool in the form of physical and non-physical materials that is deliberately used as an intermediary between teachers and students in understanding learning material so that it is more effective and efficient and that learning materials are more quickly accepted by students as a whole and attract students' interest in further learning.

One of the media that can be used to present a geometric Pythagorean proof is puzzle media. The proof of the Pythagorean theorem by approximating the area of a square with the side lengths of the square corresponding to the sides of a right triangle can be used to prove that the square of the hypotenuse is equal to the sum of the squares of the other sides.

It is hoped that by using Kabes puppy, students will be able to understand and explain the phenomena they observe, apply the Pythagorean formula by collaboratively formulating questions, think critically about complex issues, and apply the Pythagorean formula to questions and problems encountered by students. Of course, students will not be required to memorize the Pythagorean triangle theorem formula students are expected to be able to understand the material

and explanations given by the teacher and be able to understand by practicing directly on the learning media that has been made, namely Kabes Puppy.

Before applying kabes puppy to students, it is best if the contents of the puzzle in the form of small squares measuring 4 cm x 4 cm are removed, which will only leave a Pythagorean theorem puzzle container and the contents of the puzzle in the form of a triangle measuring 16 cm in height, 12 cm in height, and 20 cm in slant.

This is done with the aim of provoking or creating a sense of interest or curiosity in students about what will be done in learning because one of the functions of learning media is to attract students' attention, so that students will feel interested and focused on what is given by the teacher and leave what is being done. where these activities are not related to learning material.

Then, empty the puppy kabes of all their contents. After all the contents of the puzzle are removed, leaving a container for the Pythagorean theorem puzzle and the contents of the puzzle in the form of a triangle, students are given a simple understanding in language that is easily understood regarding the Pythagorean theorem that a right triangle has known sides for the base and high side of the triangle, making it possible to find the hypotenuse, or the longest side, using the Pythagorean theorem formula. With this Pythagorean puzzle learning medium, it can be proved that the sum of the squares of the sides of the base of the triangle and the height of the triangle will produce the hypotenuse of the triangle.

The proof is done by filling the large Pythagorean puzzle container with the contents of a colored puzzle in the form of a small square measuring 4 cm by 4 cm, which is given by each student, with each student getting one small square. If there aren't enough students, they'll get another chance to complete the puzzle.

Then give each student the remainder of the puzzle that was not set aside. Providing puzzle content to students is intended so that students are not only actively paying attention to evidence but are also active in doing it and taking part in the proof. That way, students will remember more what they did than what they heard, so they will also feel that the theorem is true and proven to be

used in finding or calculating the hypotenuse of a right triangle

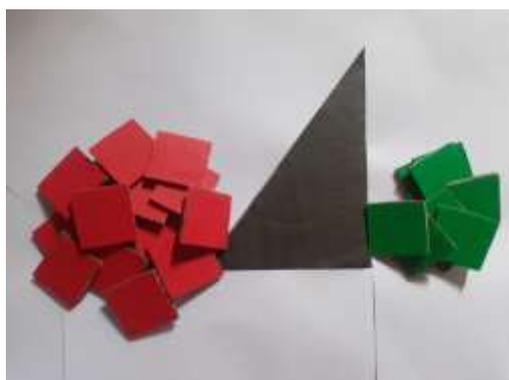


Fig. 2: Kabes Pupphy media components

After holding a small cube measuring 4 cm by 4 cm, each student is allowed to pair it in the puzzle container one by one. This can be done by placing a Pythagorean puzzle container in front of the class so that all students can pay attention easily and freely. Then direct students to take turns moving forward to the front of the class to put the contents of the puzzle that each student brought to be paired in the Pythagorean puzzle container. With this activity, it is hoped that all students will know the process of how the Pythagorean theorem occurs, and it is proven that the theorem can be used for calculations to find the hypotenuse of a right triangle or the longest side of a right triangle and also as a solution to problems that some have. school regarding students' difficulties in distinguishing which sides of a triangle should be subtracted or added when using the Pythagorean theorem.

After the students are directed to fill the puzzle container in the largest part of the container, which is delivered by 3 containers, namely those on the slanted side of a right triangle alternately, the puzzle container will be filled in with a small square measuring 4 cm by 4 cm in full, which was brought by the students without remainder.

From this activity, it can be stated to students that the area of the square located on the hypotenuse of a right triangle is the sum of the area of the square on the base side and the high side of the right triangle; if the area of each square is s^2 , then the area of the square located on the slanted side of the triangle is $s \times s = \text{area}$. s can be renamed as in a right triangle, namely a and b . Because s^2 each square is the base and high side

of a right triangle $a^2 + b^2 = c^2$, where c is the hypotenuse of the triangle.

In such a way that if you use the Pythagorean theorem formula to find the base side or high side of a right triangle, the base side or high side is the result of subtracting the square on the hypotenuse of the triangle minus one of the known squares, either the square on the base side of the triangle or the square on the high side of the triangle depending on the problem and the known sides. Using the equation as before.

So the area of the square found on the base side of the right triangle is calculated by subtracting the area of the square found on the hypotenuse of the right triangle from the area of the square found on the high side of the right triangle, or the side of the square base is calculated by subtracting the hypotenuse squared from the high side squared triangle. And the area of the square found on the high side of the triangle is the result of subtracting the square found on the hypotenuse of the triangle from the square found on the side of the base of the triangle, or it can be concluded that the high side square is the result of subtracting the hypotenuse square from the square base.

It can be formulated as follows based on the above description:

$$\begin{aligned} a^2 + b^2 &= c^2 \\ c^2 - b^2 &= a^2 \\ c^2 + a^2 &= b^2 \end{aligned}$$

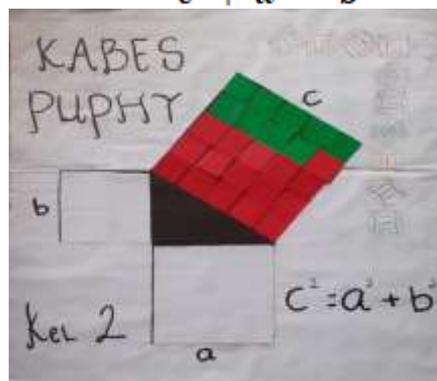


Fig. 3: Media Use

Thank God, from the activity above, we can prove the formula for the Pythagorean theorem.

III. CONCLUSION

In the world of education, the media has made a significant contribution or donation in order to provide and carry out problem solving in order to provide learning opportunities. The solution to the

learning problem offered is in the form of providing learning resources, both those that are intentionally designed and those that are selected and then utilized. Kabes Puppys learning media are easy to make as well as to use. This learning medium is used to instill the concept of the Pythagorean theorem. Not only are the student's given flexibility in using the media, but the teacher is also given the convenience of determining the puzzle pieces in the method of use that has been provided. The existence of this medium helps teachers provide learning innovations, especially in learning mathematics.

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