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Trapezoid Multimedia with Visual Thinking Approach to Enhance Achievement of 7th Grade Students

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ABSTRAK

Kesalahan utama yang dilakukan siswa dalam menyelesaikan masalah trapezium adalah kesalahan pemahamn konsep dan prinsif. Konsep dan prinsif trapezium yang disajikan dengan dilengkapi representasi visual dapat mengurangi kerumitan dan keabstrakan dibandingkan dengan hanya mengandalkan representasi verbal. Penelitian ini bertujuan untuk mengembangkan multimedia trapezium dengan pendekatan visual thinking untuk siswa kelas VII. Jenis penelitian adalah penelitian pengembangan dengan desain 4D (define, design, develop disseminate). Pada tahun pertama ini, penelitian difokuskan untuk menentukan kelayakan media berdasarkan validasi ahli, ujicoba kepraktisan, dan kefektifan. Subjek yang dilibatkan yaitu ahli materi, ahli media serta 10 orang siswa. Data dikumpulkan menggunakan lembar validasi, angket dan tes dan dianalisis menggunakan statistika deskriptif. Hasil analisis data menunjukkan bahwa tingkat kelayakan ditinjau dari ahli materi dan ahli media masing-masing adalah 92% dan 88% dengan kategori sangat valid. Hasil uji kepraktisan dan kefektifan yaitu 83,7% dan 78% dengan kategori praktis dan efektif. Oleh karena media telah memenuhi kriteria valid, praktis dan efektif maka dapat dikatakan bahwa media layak digunakan dalam pembelajaran trapesium di kelas VII. Implikasinya bahwa penerapan pendekatan visual thinking akan mampu meningkatkan hasil belajar matematika siswa.

ABSTRACT

The main factual error made by students in solving trapezium problems is the misunderstanding of concepts and principles. Trapezium concepts and principles presented with visual representations may reduce complexity and abstractness compared with relying solely on verbal representations. This study aimed at developing a multimedia trapezium with a visual thinking approach for 7th grade students. This research was development research with 4D design (define, design, develop disseminate). In this first year, research is focused on determining media feasibility based on expert validation, practicality trials, and effectiveness. The subjects involved were material experts, media experts and ten students. Data were collected using validation sheets, questionnaires as well as tests, and analyzed using descriptive statistics. The results of the data analysis showed that the level of feasibility in terms of material experts and media experts were 92% and 88% respectively with the Very Valid category. The practicality and effectiveness test results were 83.7% and 78% in the practical and effective category. Because the media met the valid, practical, and effective criteria, it can be said that the media is suitable to be applied in trapezoidal learning in 7th grade. The implication of implementing visual thinking approach in developing multimedia will be able to enhance students' achievement.

1. INTRODUCTION

The 7th grade junior high school students usually ranges from 11-12 years. This is the transition from elementary to junior high school. Furthermore, according to Piaget theory of cognitive development, it is also in the transition from the concrete operational stage to the formal operational stage (Babakr et al., 2019; Qian & Choi, 2022). It is expected that students whose thinking skills depend on concrete objects in understanding abstract concepts should begin to think abstractly and master deductive and logical ways of thinking. This transition period needs to be realized by the teacher and facilitate it well so that the process runs smoothly. The results of the research showed that innovative pedagogic approaches that can be carried out at this time are (1) presenting problem-solving activities, (2) connecting material with real-world contexts, and (3) integrating multimedia in learning (Adnan & Romli, 2022; Febrianti et al., 2021; Ulyna et al., 2019). Experts state that many advantages are obtained through the use of multimedia in learning. The use of multimedia can optimize the two information channels owned by students, namely the visual channel and the additive channel so it allows students to receive information according to their learning style preferences (Mayer, 2017; Trisnadewi et al., 2020). A deeper understanding of student concepts, increased student learning motivation, and being able to facilitate diverse student learning styles are also the main advantages of using multimedia in learning. These

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advantages have an impact on the use of multimedia in learning when it is already very massive and broad. With the advancement of information and communication technology, the development of multimedia is not difficult and expensive. The hardware and software that supports it is abundant and varied. Therefore, we can easily find learning multimedia products for all levels and all subjects, including for mathematics at the junior high school level. Generally, the object of study in mathematics is abstract, comprises definitions/agreement, deductive reasoning, and employs symbolic languagel (Abrar, 2015; Risma Handayani & Surya Abadi, 2020). Quadrilaterals, particularly trapeziums, are a subject covered in junior high school mathematics. Learning about the characteristics, perimeter, and area of a trapezium can be more difficult than learning about other quadrilaterals like squares, rectangles, and parallelograms. The findings of a study of student errors in working on trapezium problems found that common errors made by students were connected to inaccuracies in ideas and principles (Parwines & Hendriani, 2022). Conceptual errors are caused by students' lack of understanding of the meaning of trapezium elements, properties, and types, whereas principle errors are caused by students' failure to apply relationships between concepts, such as when calculating the circumference and area of a trapezium. Not understanding the notion of parallel sides, the concept of trapezium height, and the concept of circumference and area of trapezoid are all barriers to student learning in trapezium (Mulyani, 2017; Suprianingsih & Wulandari, 2020). They have not understood the formula quantities, such as the height, parallel and non-parallel sides of the trapezium. Many research projects have also been conducted in order to improve the quality of the trapezium learning process and outcomes. Students' grasp of the trapezium notion improved when they were given the treatment of multi-representational discourse learning, one of which was a visual representation (Hardiarti, 2017; Lazuardi et al., 2017). Student learning activities and outcomes in trapezium learning improve when a realistic mathematical method is used. Presenting real-world context may be utilized to make learning more engaging for students.

Existing trapezium learning optimization research is more in the form of intervention research by giving an treatment to students in the form of a learning approach. Research on the development of interactive media that is specifically made to overcome student learning barriers has never been done. With the current development of authoring tools, the opportunity for this is very wide open, for example using the storyline3-articulate application. Several interactive media based on articulate storylines have been produced by previous developers, namely (1) in learning biology in the form of cell respiration anatomy (Rea & Linn, 2017), (2) in learning chemistry in the form of biochemistry (Daryanes et al., 2023), thermochemistry, in learning physics about fluids as well as in learning natural sciences in junior high schools (Irhasyuarna et al., 2022). The development of storyline media in mathematics learning has also been carried out by previous developers, including the topic of algebra (Nissa et al., 2021), geometry (Anwar & Anis, 2020; Kakosimos, 2015; Saputro & Lumbantoruan, 2020), and opportunities (Habuke et al., 2022). There is no interactive media development for the trapezium topic.

In this study, the development of interactive media is carried out using a visual thinking approach. According to previous study, a powerful tool for developing mathematical solving and problem solving abilities is the use of a visual thinking approach (Fearnley & Amora, 2020). Furthermore several advantages of the visual thinking approach, namely: (1) helping students understand complex problems to be simpler (Asih & Ramdhani, 2019) (2) helping students understand the information conveyed more effectively (Broderick et al., 2012), and (3) stimulating students to come up with concrete and accurate ideas. It is in line with (Fernández-Fontecha et al., 2019) that visual thinking can improve conceptual thinking skills in reducing the complexity of ideas expressed in scientific writing or abstract texts. Visual thinking products can be in the form of sketches, graphs and diagrams, figures, mathematical symbols and various other semiotic sources. The uniqueness and novelty of the product developed in this study is the use of a visual thinking approach, as well as containing real world problems and equipped with formative assessments. This research aimed to develop interactive media for trapezium learning with a visual thinking approach.

2. METHOD

This development research used a 4-D design that consisted of 4 stages, namely define, design, develop, and disseminate (Thiagarajan, 1976). At the define stage, problem analysis, student analysis and curriculum analysis had been carried out. The results of the problem analysis showed that there were four main learning barriers that were the source of learning difficulties for junior high school students in learning the trapezium, namely not understanding the concept of parallel sides, concept of height, the concept of area around and area of a trapezium. Students need appropriate visual representations in order to form correct conceptual understanding and retention. The results of the student analysis showed that the age of class VII junior high school students was a period of transition from operational to formal cognitive development. This transition must be carried out smoothly by not necessarily breaking student dependence on mental objects, but slowly being diverted from concrete objects by replacing them with visual icons that represent these abstract objects. The

second stage, namely the design stage, had also been carried out by compiling a storyboard first before being implemented into a media draft. Storyboards were arranged using a hybrid model with a mixed hierarchical navigation design. The media model created used a hybrid model that was a combination of the tutorial model and the drill and practice model. The tutorial model was intended to deepen user understanding by presenting content using visual thinking approach, while the drill and practice model aimed to provide broad opportunities for users to practice the skills acquired. Mixed hierarchical navigation design is a navigation design that combines hierarchical and non-hierarchical designs. The design makes it possible to organize content into different levels (hierarchy) and can also provide quick access to specific (non-hierarchical) pages or features (Chandra & Orlando, 2022). Another feature that is also a specification of this interactive media is the presentation of the content using a visual thinking approach and the questions are contextually oriented.

The third stage was the developed-stage. The media design created at the design stage was then developed into a media draft using the articulate storyline application. The media draft was then tested for feasibility by establishing 3 criteria, namely valid, practical and effective. The media was valid if two experts, namely material experts and media experts, state that this media was feasible to proceed to the next stage. Validity data was collected using a validation sheet. Media is said to be practical if users (teachers and students) judge that the media is feasible to use. The effectiveness of the media in terms of the average student acquisition score was at least in the high category. Media practicality and effectiveness data were collected using questionnaires and tests through small group trials involving 10 students. Data type, instrument, and data analysis techniques are show in Table 1.

Table 1. Data Type, Instrument and Data Analysis Techniques

Data Type	Instrument	Data Analysis Technique
Material Validity	Validation sheet	Descriptive statistic
Media Design Validity	Validation sheet	Descriptive statistic
Practicality	Questionnaire	Descriptive statistic
Eeffectiveness	Test	Descriptive statistic

The material validation sheet adopts indicators developed contain 3 aspects, namely curriculum, concepts, and language (Daryanes et al., 2023). The validity of media design also adopts an instrument contains three aspects, namely display design, animation and usability. The practicality of the media was measured using a questionnaire whose statement adopted a questionnaire. The effectiveness of the media is measured by using a learning achievement test that measured the attainment of basic competencies covering material types and characteristics of the trapezium, the circumference of the trapezium and the area of the trapezium. The test consisted of 10 multiple choice questions. The data collected were then analysed descriptively using the criteria in Table 2. The media developed were at least in the category of valid, practical and effective.

Table 2. Validity Criteria

Interval	Category		
	Validity	Practicality	Effectiveness
5≤x≤100	Very Valid	Very Practical	Very effective
5≤x<85	Valid	Practical	Effective
60≤x<75	Fairly Valid	Fairly Practical	Fairly Effective
55≤x<60	Invalid	Less Practical	Less effective
0≤x<55	Totally Invalid	Very Impractical	Very Ineffective

3. RESULT AND DISCUSSION

Result

This development research had been carried out up to the develop stage and had resulted an interactive media prototype with a visual thinking approach for learning trapezoid quadrilaterals in junior high schools. This prototype contained three main menus, namely basic competencies, materials and evaluation. The basic competency menu was used to convey information regarding learning objectives and material limitations within the scope of media content. The material menu basically contained a discussion or description of material with the presentation that emphasized a visual thinking approach, namely trying to provide concrete and visual illustrations of abstract mathematical concepts and processes to make it easier for children to understand. The trapezium meter was divided into 3 sub-matters, namely (1) the properties and types of the trapezium, (2) the perimeter of the trapezium and (3) the area of the trapezium. In each sub-menu the material was integrated as

well as exercises in the form of formative tests accompanied by direct feedback. This formative assessment can detect the material students did not understand and also provided brief instructions as scaffolding that requires students to get the correct answer. The last menu was evaluation. The evaluation menu was used to measure the level of mastery of the material. By completing all the evaluation questions and by submitting the answers students will find out what percentage of their level of mastery of the material. Students can also review that items, whether the answers were correct or still wrong. There was also a button to try again. When the interactive media was run, the user started the page that was preceded by an intro in the form of a video bumper from the Indonesian University of Education. The front page is show in **Figure 1**.

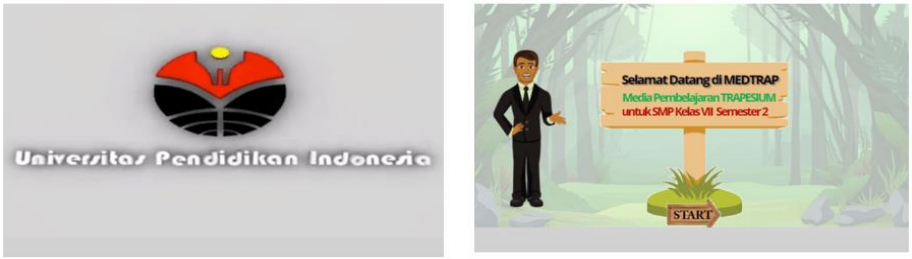

Figure 1. Front Page

After selecting the "START" button, the page moved to the "Main Menu" that consisted of sub menus namely basic competencies, materials and evaluation. The material page contains 3 sub-materials. Each of the sub-materials of his presentation used a visual thinking approach to reduce the level of abstraction of mathematical concepts and processes that were usually presented verbally. The specification of the prototype was in the form of interactive learning media for Class VII Middle School material with trapezium material presented with a visual thinking approach assisted by formative assessment with direct feedback. This prototype had gone through the feasibility evaluation stage that will be described in the next section. This interactive media is feasible if it meets 3 criteria, namely valid, practical and effective. The feasibility assessment of the media draft has been carried out and the results can be seen in Table 3, Table 4, and Table 5.

Table 3. The Results of Material Expert and Media Expert Validation

Indicator	Score	Indicator	Score
The material is in accordance with the basic competencies	5	Display design according to the characteristics of students	4
The material is in accordance with the learning objectives	5	The illustrations used are clear	5
Concept presented properly	5	Navigation makes it easy for students to explore media	4
The cases/examples presented are in accordance with the material	4	The size and colour of the writing is clearly legible	5
The material is presented clearly and easy to understand	4	Buttons are consistent in shape and colour	4
The material is described fully	5	Background media does not interfere with the main display	4
The depth of presentation of the material is adequate	4	Animation is not superfluous	4
Visualization makes it easier to understand the material	5	Interactive	4
The delivery language is simple and easy to understand.	5	Medium is easy to use	5
Language according to the spelling that applies.	4	Media can be used in various devices	5
Score Total Material Expert (%)	46 (92%)	Score Total Media Expert	44 (88%)

Table 4. Student Responses to Media Practicality

Indicator	STS	TS	R	S	SS
It is easy to get started with media	0	0	0	8	2
Simple and uncomplicated media navigation	0	0	0	7	3
Easy to understand the material on the media	0	0	2	5	3
Sufficient examples	0	0	1	7	2
Practice feedback is very helpful	0	0	3	4	3
Animation helps understand the material	0	0	1	5	4
Simple and easy to understand illustrations	0	0	1	5	4
Total	0	0	8	41	21
Score	0	0	24	164	105
Total Score / Average (%)	$\frac{24+164+105}{10} = 29,3$ **(83,7%)**				

Table 5. Recapitulation of Media Feasibility Assessment Results

Feasibility Aspect	Score	Category
Material expert assessment	92	Very Valid
Media expert assessment	88	Very Valid
Student response	83.7	Practical
Learning outcomes	78	Effective

Discussion

The results showed the screenshots of the trapezium learning multimedia prototype displayed with a visual thinking approach. This prototype is the result of a revision of the media draft after receiving input from the experts and users. There were several suggestions for the improvement from material experts accommodated in the development of this media. The first input related to the definition of a trapezium. Material experts suggested that a trapezium should be defined as a quadrilateral that has one and only one pair of parallel sides. Obviously in this sense, a parallelogram, rectangle, square and rhombus are not trapeziums.

After being revised, the trapezium definition, also known as the inclusive definition, was used. This definition is widely used in United States textbooks. The second input related to animation to explain the nature and types of trapeziums, the presentation using a visual thinking approach needs to be sharpened again. Visual thinking products can be in the form of sketches, graphs and diagrams, figures, mathematical symbols and various other semiotic sources. Improvements have been made by adding visual representations in the form of animations for the material properties and types of trapeziums, including material for the perimeter of the trapezium (Made & Bayu, 2019; Umbara et al., 2020). The third input related to the presentation of the area of the trapezium material. The area of the original trapezium is animated by transforming the trapezium into a parallelogram. With the conservation law of area and the assumption that students have understood the parallelogram area, students will also be able to independently find and understand the area of a trapezium based on their previous understanding of the parallelogram area (Damayanti & Wiarta, 2022; Karwati et al., 2018). The material experts suggested using more than one illustration of the area of a trapezium with a parallelogram approach. Suggestions are also given to use other visual approaches, for example the area of a rectangle or triangle. This input was in accordance with opinion that state by displaying various approaches in solving the broad trapezium can train students creative thinking skills (Dewi, 2022; Hadi et al., 2022). Based on this input, improvements were made so that in this media there were 4 approaches to reduce the area of the trapezium.

Apart from material experts, input from media experts was also accommodated in improving the draft into a prototype. The first input related to the navigation used to make it more flexible. Improvements have been made by applying a mixed hierarchical navigation design, so that at certain stages it is possible for students to flexibly move to other material they wish to learn without having to complete the current material (Antika et al., 2019; Trisnadewi et al., 2020). According to previous study, this design makes it possible to organize content into different levels (hierarchy) and can also provide quick access to specific pages or features (non-hierarchical) (Chandra & Orlando, 2022). Navigation like this gives freedom to students to start learning from material that they think is easier to understand first. The second input related to object consistency, colour and button position in each slide. At first this was not paid much attention to, but with this input, consistency has been made in the position of the buttons, namely the next button in the lower right corner, the back button in the lower left corner, while the home button is placed in the upper right corner (Kumala Dewi et al., 2018; Putri et al., 2021). The third input relates to the accuracy and smoothness of the animation used. Some animations that weren't accurate and transitions weren't smooth enough have been fixed for a nicer and smoother look.

In addition to qualitative assessment, media evaluation was carried out quantitatively. Material experts and media experts gave media assessment scores of 92% and 88% respectively that were in the excellent category. It showed that the media prototype had met the material indicators and media indicators very well. In terms of material, experts argued that the material was in accordance with the curriculum, the presentation is easy to understand, the truth of the concept was correct and the language was simple and not confusing. While media experts consider that the appearance of the media was in accordance with the characteristics of the students, the navigation was not complicated, the animations and illustrations were adequate and not excessive, and the media was interactive (Kumala Dewi et al., 2018; Nurcholif et al., 2021; Sari & Yuhendri, 2021). Thus, based on the expert, it can be said that the media meets the valid requirements. Regarding the practicality of the media, students responded positively with an average score of 83.7%.

These results showed that students did not experience significant difficulties in using the media or in other words the media meets the practical requirements. Media can be easily run without any difficult device requirements. Students considered that media navigation was not complicated, animations and illustrations help understand the material and the feedback in the exercises is very helpful and motivating in problem solving (Muhali, 2019; Rahmawati & Atmojo, 2021). This positive response was also observed from the enthusiasm of students when conducting media trials. They were very excited about learning trapezium with the help of the media. The 10 respondents completed all the activities provided in the media with great curiosity. Based on results of the completion of the evaluation activities, the level of mastery of their material can be measured, namely with an average of 78. These results showed that the level of student's material mastery through media-assisted learning was in the effective category (Lampropoulos et al., 2019; Purwanita et al., 2019).

Based on the discussion of research results, it has been found that the developed media prototype met requirements (valid, practical, effective) and it can be said to be feasible. Experts considered that the media was good quality in terms of content and media design and students respond positively to the application of media in class. The level of mastery of student material through the use of this media was good, reaching 78%. It is in line with the results that state visual thinking can improve conceptual thinking skills in reducing the complexity of ideas expressed in scientific writing or abstract texts (Fernández-Fontecha et al., 2019). Learning barriers related to the errors in trapezium concepts and principles as raised by previous study can be minimized (Parwines & Hendriani, 2022). The visual thinking approach used had succeeded to make students understand the concept of parallel sides and the concept of the height of a trapezium so that with this provision they can successfully apply in solving problems about the area of a trapezium. The resulting media complements the trapezium learning reference that has been the main reference in the form of textbooks. Even though the mathematics multimedia developed at this time is abundant, there is no one that specifically studies trapeziums with a visual thinking approach so that the results of this study can be used as a new alternative in teaching trapeziums in junior high schools. Further research in the form of experiments to test the influence of media with a wider population needs to be carried out so that stronger empirical evidence is obtained and it shows the effectiveness of this media in trapezium learning in junior high schools.

4. CONCLUSION

The trapezium learning multimedia for 7th grade students that was developed using a visual thinking approach had fulfilled the criteria of being feasible in terms of validity, practicality, and effectiveness. The uniqueness of this media is the presentation of its content using a visual thinking approach that has been equipped with contextual problems, as well as formative assessments with direct feedback. Further research in the form of extensive trials involves larger populations' needs to be carried out in order to obtain empirical evidence related to media effectiveness.

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