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The development of learning media based on visual, auditory, and kinesthetic (VAK) approach to facilitate students' mathematical understanding ability

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Abstract. This study aimed to develop learning media based on Visual, Auditory, and Kinesthetic (VAK) approach that was valid and practical and able to facilitate students' mathematical understanding ability. This research is conducted at State Junior High School 20 Pekanbaru. The subjects of this research are media experts and subject matter experts as validators and students of Grade 8th at State Junior High School 20 Pekanbaru. The objects of this research are learning media based on Visual, Auditory, and Kinesthetic (VAK) approach and students' mathematical conceptual understanding ability. Based on the validity test, the learning media based on Visual, Auditory, and Kinesthetic (VAK) approach was categorized as very valid with 86.20% validity rate. Based on practicality test, learning media based on Visual, Auditory, and Kinesthetic (VAK) approach was very practical for small group with 90.51% practicality level, and very practical for large group with 90.17% practicality level. Based on the students' mathematical understanding ability test, the learning media based on Visual, Auditory, and Kinesthetic (VAK) was very effective with 89.74% effectivity rate. From these results, the developed learning media was very valid, very practical, and very effective to facilitate students' mathematical understanding ability.

1. Introduction

Understanding has become a very important aspect in mathematics learning principle, because through understanding, student can really learn meaningfully. Brownell (1953) said that learning happens through meaningfulness and understanding [1]. Without understanding, students will not learn, and make the learning process become meaningless. Understanding also becomes basic ability in every learning process, including mathematics. Students cannot start solving a problem or thinking creatively without understanding the concept that they learn.

In practice, understanding became one of the factors of students' mathematics achievement that is less satisfactory. This is because the main problem of low achievement of mathematics is an understanding of mathematical concepts that are less deep, which is mostly limited to memorizing. Thus, an effort is needed so that students can really understand the concepts given and for the learning of mathematics can take place effectively to produce a meaningful learning.

To improve the effectiveness of learning, teachers should use teaching materials in accordance with the needs and characteristics of students. One of the teaching materials that can be used by teachers is learning media. Learning media that serves as a communication tool is used for channeling messages



and can stimulate the thoughts, feelings, and ability of students so as to encourage the process of effective and efficient learning[2].

Djamarah (2010) argues that media play a role in the learning process, because in the event the obscurity of the material presented can be helped by presenting the media as an intermediary[3]. Besides, learning media also helps learners improve understanding, presents data with interesting and reliable, facilitate interpretation of data, and compact information[4].

In addition, at the age of 12-15 years, the students' thinking is still semi concrete but the teacher has provided the learning material in the form of abstract, so it takes tools to concrete ideas and provides clarity so that knowledge and learning experience can be clearer and more easily understood[5]. Sundayana (2015) also asserts that learning media can be used to build understanding and mastery of educational objects[6].

From the authors' observation of the learning process, the presentation of the material is based on textbooks and electronic books in circulation, media usage is very minimal, and if there is media use, it usually in the form of media that spend a lot of time, energy, and money of students and teachers, such as making cubes and cuboid of cardboard and wire. The use of media like this cannot be done for many times, as it will disturb the learning program in the school for the time consumed in the making and using of the media.

One of the solutions to the problem is the use of computer-based learning media, such as Microsoft Office Power Point. The advantages of Microsoft Office Power Point media is to combine all the elements of media such as text, video, animation, image, graphics, and sound into a single presentation, so that all those elements can be combined with the student learning modalities. Rusman said that this program can accommodate students who are visual, auditory and kinesthetic types[7].

One of the approaches that can be applied to Microsoft Office PowerPoint learning media is Visual, Auditory, and Kinesthetic (VAK) approach. The learning media based on this VAK approach will include the three characteristics of Visual (learning by sight), Auditory (learning by listening), Kinesthetic (learning with motion and emotion)[8]. Basically, these three characteristics are different information processing. Based on the dual coding theory of multimedia learning, someone has separated channel to process visual information and auditory information. Images are processed in visual channel and narration is processed in an auditory channel[9]. This also applies to movements and emotions which are processed in different channels. However, in the presence of media that can combine all of these characteristics, learning will be more effective.

Based on the results of research stating that by adding animation to the narration, it can help students understand more about the material or explanations presented[10], then the use of media that combine these three characteristics is very good to facilitate students' mathematical understanding.

The VAK approach consists of three stages: exploration, elaboration, and confirmation[11]. In exploration activities, teachers guide the students to discover new subject matter independently, fun, and, relevantly, involving the five senses suitable with the learning style of VAK. In elaboration activities, teachers help students to integrate and absorb new knowledge and skills which is appropriate for VAK learning style. In confirmation activities, or can be referred as the performance stage of the results, teachers assist students to apply and extend new knowledge and skills that they get on learning activities so that the learning outcomes have good progress.

Based on those, authors will conduct a research to develop a learning media that is valid, practical, and effective to facilitate students' mathematical understanding ability. The result of the research will show the validity, practicality, and effectivity of the learning media based Visual, Auditory, and Kinesthetic (VAK) approach to facilitate students' mathematical understanding ability.

2. Method

This research used research and development (R & D) method. Research and development is a process or steps to develop new products, or to improve the existing products. This research was conducted at State Junior High School 20 Pekanbaru for 8th grade students. The study was developed using ADDIE (Analysis-Design-Development-Implementation-Evaluation) model. Benny A. P (2009) states that one

model of learning system design is simple and easy to learn is the model of ADDIE [12]. Ningsih (2013) also agrees that the ADDIE research model is one of the model of learning system design that shows the basic stages of the design of the learning system is simple and easy to learn [13]. Learning media development steps using the ADDIE model according to Moelanda (2003) consists of five stages: analyze, design, develop, implement, and evaluate [14]. The steps in product development, research and development model is more rational and more complete than the 4D model. Therefore, this model can be used for various forms of product development such as models, learning strategies, learning methods, media and teaching materials.

The procedures involved are Analysis (performance analysis and need analysis), Design (product making), Development (validation) Implementation (practicality and effectivity test) and Evaluation (revision based on validators and practicality tester's comments).

The data analyses used are the qualitative and quantitative descriptive questionnaires. The descriptive qualitative analysis is used to analyze data from technology experts and subject matter expert, and the comments of the revised educational game. The descriptive quantitative analyses are:

$$\text{Validity} = \frac{\sum \text{obtained score}}{\sum \text{score criteria}} \times 100\%$$

$$\text{Practicality} = \frac{\sum \text{obtained score}}{\sum \text{score criteria}} \times 100\%$$

The level of validity and practicality can be seen in the following table:

Table 1. Level of validity / practicality of educational games [12]

Ideal Percentage (%)	Categories
0-20	Not Valid/ Not Practical
21-40	Less Valid / Less Practical
41-60	Enough Valid/ Enough Practical
61-80	Valid / Practical
81-100	Very Valid / Very Practical

As for effectivity, students' score are categorized based on Minimum Mastery Criteria (MMC), which are 75 for mathematics at State Junior High School 20 Pekanbaru.

$$\text{Effectivity} = \frac{\sum \text{students who meet the MMC}}{\sum \text{students who take post test}} \times 100\%$$

The level of effectivity can be seen from the following table:

Table 2. Level of Effectivity of Educational Game to Facilitate Student Mathematical Problem Solving Ability [13]

Effectivity Level	Categories
81% - 100%	Very Effective
61% - 80%	Effective
41% - 60%	Enough Effective
21% - 40%	Less Effective
< 20%	Not Effective

3. Result and discussion

The first step of learning media development is Analysis that consists of performance analysis and need analysis. Performance analysis conducted with interviewing mathematics teacher at State Junior High School 20 Pekanbaru, where we found that majority mathematics learning at State Junior High School 20 Pekanbaru still using textbooks as main sources, with a little use of teaching aids and non-IT learning media. Need analysis conducted with curriculum and concept analysis, and we found that one of mathematics ability that need to be facilitated is mathematical understanding and one of the subject that with suitable Visual, Auditory, and Kinesthetic (VAK) approach is cube and cuboid. As it was researched by Melton (1990) found that Chinese (PRC) university students (N = 331) favored Kinesthetic, Tactile and Individual styles, and disfavored Group styles.

The next step is Design that consists of creating the media using Microsoft Office Power Point 2013. In designing the product, the focuses are to make an interesting interface and content of cube and cuboid based on Visual, Auditory, and Kinesthetic (VAK) approach and can facilitate Mathematical understanding ability of 8th grade students.

The Development step after that is the validation. The validation process is done by technology and subject matter experts.

The validation results from technology experts can be seen in the following table:

Table 3. Validation Results of Learning Media Based on VAK Approach Developed from Technology Experts

Variables of validity	Validity score	Criteria
Simplicity	85.77%	Very Valid
Alignment	90.52%	Very Valid
Learning Interactions	83.92%	Very Valid
Balance	89.34%	Very Valid
Form	91.43%	Very Valid
Colour	86.73%	Very Valid
Language	88.51%	Very Valid
Sound and Media Usage	87.17%	Valid Very
Average Score	87.92%	Very Valid

The validation results from subject matter experts can be seen in the following table:

Table 4. Validation Results of Learning Media Based on VAK Approach Developed from Subject Matter Experts

Variables of validity	Validity score	Criteria
Content Quality	86.82%	Very Valid
Learning Quality	81.22%	Very Valid
Interaction Quality	87.56%	Very Valid
Display Quality	82.67%	Very Valid
Visual, Auditory, and Kinesthetic (VAK) Approach	84.13%	Very Valid
Average Score	84.48%	Very Valid

The average validation score from technology and subject matter experts can be seen in the following table:

Table 5. Validation Score of Learning Media Based on VAK Approach Developed from Technology and Subject Matter Experts

Experts	Validity score	Criteria
Technology Experts	87.92%	Very Valid
Subject Matter Experts	84.48%	Very Valid
Average Score	86.20%	Very Valid

The results of data analysis showed that the learning media based on VAK approach that developed is very valid in technology and subject matter side and can be used for Implementation after small revisions. It means that based on technology and content used, the developed learning media can be used in learning process.

The next step is Implementation, consist of practicality test with small group tester and large group tester followed by effectivity test. The practicality test phase I was conducted with small group tester consisting of six students. The results are presented below.

Table 6. Practicality of Learning Media Based on VAK Approach Developed from Small Group Tester.

Variables of practicality	Practicality score	Criteria
Student Interest and Media Display	94.77%	Very Practical
Usage Process	95.16%	Very Practical
VAK Approach and Mathematical Understanding Ability	82.58%	Very Practical
Time	93.39%	Very Practical
Evaluation	86.64%	Very Practical
Average Score	90.51%	Very Practical

From the data above, it showed that the learning media based on VAK approach that developed is very practical for small group using and can be used for large group test after small revisions.

Then, practicality test phase II was conducted with large group tester consisting of 39 students. The results are presented below.

Table 7. Practicality of Learning Media Based on VAK Approach Developed from Large Group Tester.

Variables of practicality	Practicality score	Criteria
Student Interest and Media Display	87.43%	Very Practical
Usage Process	89.57%	Very Practical
VAK Approach and Mathematical Understanding Ability	92.46%	Very Practical
Time	91,23%	Very Practical
Evaluation	90.18%	Very Practical
Average Score	90.17%	Very Practical

From the data above, it showed that the learning media based on VAK approach that developed is very practical for large group using and can be used without any revisions. It means that the developed learning media is very interesting to be used and that students can understand the content without difficulty. It also means that the developed learning media can be produced and used for large.

The effectivity of the learning media based on VAK approach that developed is done in the form of post-test with mathematical understanding based question to large group tester. The result of the post-test was 35 of 39 students that take the post-test meet the Minimum Mastery Criteria (MMC) or have scored at least 75. It means that the effectivity score of the educational game that developed has effectivity rate of 89.74%, with very effective criteria to facilitate students' mathematical understanding ability.

Finally, the last step is Evaluation that consists of revision based on validators' comments and revision based on students from small group tester comments.

The revisions based on validators' comments can be seen in the following table:

Table 8. Revisions of Learning Media Based on VAK Approach Developed Based on Validators' Comments

Validators	Revisions
Technology Expert I	<ul style="list-style-type: none"> • Fixing some slides that have typing errors. • Fixing some links that have linking errors. • Replacing back sound with softer music.
Technology Expert II	<ul style="list-style-type: none"> • Fixing the choice of writing's font and colour.
Technology Expert III	<ul style="list-style-type: none"> • Adjusting learning media with VAK approach. • Adding practice questions that related to daily life. • Giving specificity to the learning media.
Subject Matter Expert I	<ul style="list-style-type: none"> • Writing the formula in italic. • Fixing editorial writing.
Subject Matter Expert II	<ul style="list-style-type: none"> • In the example, giving the lag time between the appearance of the questions and the solutions so that students can think for a moment before looking at the answers.
Subject Matter Expert III	<ul style="list-style-type: none"> • Repairing how to determine the angle dot.

After the learning media based on VAK approach that developed is revised based on validators' comments, the learning media developed could be used for implementation for small group tester, which comments are became a base for the next revision, as can be seen in the following table.

Table 9. Revisions of Learning Media Based on VAK Approach Developed Based on Small Group Testers' Comments

Testers	Revisions
Student 2	<ul style="list-style-type: none"> • Fixing writing mistake in the answer's elaboration on Activity Example 2.
Student 3	<ul style="list-style-type: none"> • Fixing the shapes' colour in subject presentation that was too dark, that make the writing less visible.
Student 5	<ul style="list-style-type: none"> • Fixing the question writing mistake in Exercise 3.

4. Conclusion

Based on this research, the learning media based Visual, Auditory, and Kinesthetic (VAK) approach that authors developed has 86.20% validity (very valid), 90.51% practicality (very practical) for small group tester, 90.17% practicality (very practical) for large group tester, and 89.74% effectivity (very effective). Therefore, the developed learning media based on VAK approach can facilitate students' mathematical understanding ability.

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