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Development of Interactive Multimedia Based on STEM Wave Material for High School Students

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Abstract

This research analyses the results of expert validation of interactive multimedia development based on STEM wave material for high school students. This development research used the Alessi and Trollip model, which includes the planning, design, and development stages. Validation is one of the stages in product development. Conducted by one material expert and one media expert. The validation results were analyzed by converting quantitative data into qualitative data with five scales. The results of material validation include content feasibility with 17 indicators obtained an average value of 0.823, presentation feasibility with nine indicators obtained an average value of 0.826, and language assessment with ten indicators obtained an average value of 0.825. It means each indicator belongs to the very high category The results of media validation which include graphics with seven indicators obtained an average value of 0.892, colouring with three indicators obtained an average value of 0.916, interactivity with 11 indicators obtained an average value of 0.909, and sound with three indicators obtained an average value of 0.833, which is each indicator included in the very high category. Experts argue that interactive multimedia based on STEM wave material for high school students is considered valid and worth testing.

Keywords: Interactive Multimedia; Physics; STEM; Wave Material

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INTRODUCTION

Technology as a tutor (computers provide instructions and guide users), technology as a teaching tool and technology as a learning tool are three domains of use in educational technology (Stošić, 2015). Pre-service teachers can help the education system by effectively engaging and teaching Generation Z students. School systems must be equipped with ICT resources for students to connect and respond to one another, and curricula must be designed to promote a student-centred environment (Boholano, 2017).

Most science subjects are abstract material that is abstract and difficult to understand. In addition, it can make it easier for students to understand the material being taught. The distribution of learning content through technology is the right solution to answer these problems, especially for abstract science material that is difficult to understand. This is commonly referred to as educational or learning technology (Babiker, 2015).

Learning media is a container that provides information when learning takes place (Arthur, Luthfiana, & Musalamah, 2019). Learning media, such as multimedia, is very important in learning. The development and popularity of computers and multimedia technology have stimulated researchers to develop digital content and systems for learning (Hung, Huang, & Hwang, 2014). The use of multimedia can provide high-quality learning with more clear understanding because it displays clear visualizations combined with the message conveyed (Cairncross & Mannion, 2001).

The use of multimedia in physics learning is expected to overcome the problem of limited teaching aids and media for students to use and overcome the limited time allocation during learning. The use of multimedia is also expected to increase the interest and attention of students so that it positively affects students' cognitive abilities.

Physics is a branch of science that describes how nature works using the language of mathematics. It involves the study of universal laws, behaviour, and relationships among various physical phenomena (Argaw, Haile, Ayalew, & Kuma, 2017). Understanding science and mathematics, practical science, technology, and engineering practices are priorities for national education programs worldwide (Kelley & Knowles, 2016). The implementation of STEM education in schools around the world is to prepare the future workforce with scientific and mathematical backgrounds to enhance the development of cross-disciplinary skills (Ejiwale, 2013).

The science, technology, engineering, mathematics (STEM) approach combines science, technology, engineering, and mathematics into one overall curriculum. Creativity, critical thinking, collaboration, and communication or the term "4C", are skills that must be included in the STEM curriculum (Pramuji, Permanasari, & Ardianto, 2020). Creating the character of students who can identify a concept or knowledge (science) and apply that knowledge with the skills (technology), they have to create or design a method (engineering) with analysis and based on mathematical data calculations (mathematics) in order to obtain a solution to solving a problem so that human work becomes easier, can be created through STEM-based learning (Permanasari, 2016).

To face the challenges in the 21st century, education is one of the important aspects that can provide solutions to dealing with these challenges. STEM education can be an alternative science learning that can build a generation ready to face challenges in the 21st century (Fathoni, Muslim, Ismayati, Rijanto, & Nurlaela, 2020). Designing, developing and utilizing technology, cognitive, affective, and applying knowledge is an advantage in applying STEM education in learning. In addition, the advantages of applying STEM-based learning can train students to apply their knowledge to make designs to solve problems related to the environment by utilizing technology (Mulyani, 2019).

Based on the results of questionnaires and interviews with physics teachers, it is known that there are still many teachers who find it difficult to get multimedia learning, especially on abstract physics material. The teacher also said that making multimedia learning was difficult because it took a long time and lacked facilities to support the use of multimedia. In addition, the teacher also said that making multimedia was difficult and that they had to use devices or applications that were difficult to obtain. Most teachers only use ordinary power points as learning media. One of the factors that cause the teacher's low interest in making multimedia is that they do not know how to make multimedia itself. Researchers have created stem-based interactive multimedia easily accessible to students based on these problems. The use of this multimedia can be accessed anywhere and anytime, and it only requires a smartphone or laptop device and an internet connection.

Research by (Syaputrizal & Jannah, 2019) and (Usmeldi, 2015)shows that using learning media can increase students' independence and competence. The study used special software that must be installed on the laptop before use. In this study, a valid STEM-based interactive multimedia has been developed for high school students. The developed multimedia is also practical to use because there is no need to install and it can be used immediately. In addition, the developed multimedia can be used on hardware such as laptops or smartphones, making it more practical for students to use anywhere and anytime.

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METHOD

Research and Development is the method used in this research. This study aims to produce interactive multimedia based on STEM wave material for high school students. The development model used in the development of STEM-based multimedia is Alessi and Trollip, which includes the stages: of planning, design, and development (Alessi & Trollip, 2001).

The subjects in this study are the targets intended by researchers to be studied, that is, interactive multimedia based on STEM wave material for high school students. The data collection technique of this research used a questionnaire, validation sheet, and interviews. Research data analysis techniques using questionnaire analysis and validation sheet analysis.

The first stage of Alessi and Trollip's development research is planning, which identifies the students' needs. Needs analysis to determine the product's purpose in accordance with the core competencies. This needs analysis was carried out through a literature study (library review and previous research) and a questionnaire distributed via google form regarding the needs of students and an overview of the learning process carried out by the teacher. Furthermore, the analysis of the curriculum, which there are KI and KD.

The second stage designs. In media design, the step that will be taken is to determine the physics subject matter for senior high school. Determine Core Competencies and Basic Competencies following the themes raised in developing learning multimedia. After the material is compiled, determine the device used in making multimedia, namely Construct 2.

The development stage is the final stage in development research, according to Alessi and Trollip. The results of this activity create learning media that is ready to be tested. At this stage, the multimedia draft was carried out with an alpha test (expert validation) to determine the validity of the developed media. The expert team involved in the validation are media experts and material experts. After revision and validation (feasible to be implemented), a beta test was carried out to determine the practicality of multimedia. The Instructional Design Model is shown in Figure 1.

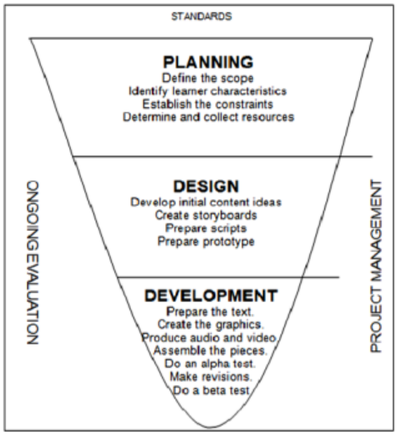


Figure 1 Model of Instructional Design

The data used in this study is an assessment of the feasibility of the developed media. The data obtained include the results of media validation and material validation. The expert validation analysis uses the mean score of the V Aiken formula (Aiken, 2015).

$$V = \frac{\sum s}{[n(c-1)]}$$

s = r – Io
Io = The lowest validity score (1)
r = The score given by the validator
c = The highest validity score (5)
n = number of validator

After obtaining the validity number, it can be determined the level of multimedia validity with the provisions in Table 1.

Table 1 Category of Media Validity Level (Azwar, 2012)

Average	Category
0.8 – 1.000	Very High
0.6 – 0.799	High
0.4 – 0.599	Medium
0.2 – 0.399	Low
0 – 0.199	Very Low

RESULT AND DISCUSSION

According to Alessi and Trollip, the planning stage consists of determining the scope, identifying the characteristics of students, determining obstacles/barriers, making planning documents, making implementation instructions, collecting sources, discussing initial ideas, determining media, and obtaining approval from the client.

At the design stage, the activities are developing initial concepts, making flowcharts, making storyboards, and collecting media content. At the development stage, the activities carried out were preparing the text, writing program code, creating graphics, preparing supporting materials, doing alpha testing, revising, and conducting beta tests.

After the product is produced, proceed to the alpha test stage or expert validation. This stage is important because the multimedia produced is assessed by experts or competent people in a particular field to find out that the product already has valid criteria and has the feasibility to be tested.

Multimedia validation analysis was carried out by two validators, namely, the material validator and the media validator.

Material Validation

The focus of material expert validation is to assess the product on the material aspect (Saputri, Ragil, & Ardiansyah, 2021). The results of the material validator's quantitative assessment of STEM-based interactive multimedia wave material for high school students were processed using the V Aiken formula.

Validation is done by providing a material expert feasibility test questionnaire. The questionnaire consists of three aspects, namely aspects of content feasibility, presentation feasibility, and language assessment. The answers are on a scale from 1 to 5. The results of the validation by material experts can be seen in Table 2.

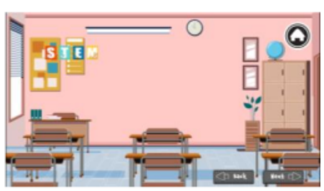
Table 2 Material Validation Result

Rated Aspects	Number of Indicators	Average	Cate-gory
Content feasibility	17	0.823	Very High
Presentation feasibility	9	0.826	Very High
Language assessment	10	0.825	Very High

Based on Table 2, the results of material validation which include content feasibility with 17 indicators obtained an average value of 0.823 with a very high category, presentation feasibility with 9 indicators obtained an average value of 0.826 with a very high category, and language assessment with 10 indicators obtained an average value of 0.825 with very high category. 93% of Students feel confident that learning Physics using multimedia learning will be interesting (Diansyah, Suyatna, & Viyatni, 2021).

The displays in interactive multimedia products provide a pleasant learning experience for students. This is in line with Wiana, (2018) if a more attractive display can provide a better learning experience. This can be obtained by using multimedia in learning. The validator provides suggestions for the multimedia, such as using a larger font to make it clearer for the user to view the content in the multimedia. (Arsyad, 2016) explains that the principles of developing computer-based media that need to be considered include using fonts with normal sizes and layers that should not be too dense. Another suggestion is to delete empty or useless slides. Researchers also add material to the multimedia so that the useless slides are filled with learning materials, as we can see the difference in Table 3.

Table 3 Before and After Material Validation

Before Validation	After Validation
	

This proves that interactive multimedia is valid with a very high category and is feasible to use. (Arikunto, 2010) also said that validity is the level of validity of a product. It means that the higher the validity of the teaching media, the more valid the teaching media (Widodo, An'nur, & Mahardika, 2017).

Media Validation

Media validation results are listed in Table 4.

Table 4 Media Validation Results

Rated Aspects	Number of Indicators	Average	Cate-gory
Graphics	7	0.892	Very High
Coloring	3	0.916	Very High
Interactivity	11	0.909	Very High
Sound	3	0.833	Very High

Based on Table 4, the results of media validation which include graphics with 7 indicators have an average of

0.892 with a very high category, colouring with 3 indicators has an average of 0.916 with a very high category, interactivity with 11 indicators has an average of 0.909 with a very high category, and sound with 3 indicators are obtained with an average value is 0.833, which means it is included in the very high category and is suitable for use.

The use of images in learning media has the advantage that it is concrete, more realistic, and can clarify a phenomenon in various fields, so it is found that images as learning media can improve student learning outcomes (Mawarni, Tandi, & Rizal, 2014). The assessment results with a high or very high category indicate that the multimedia components have been fulfilled correctly, so it can be concluded that the developed multimedia is appropriate and feasible to be used as a learning media.

The advantage of this multimedia is that it is easily accessible for students. The multimedia can be used using hardware such as smartphones, laptops, or computers. The use of this multimedia can also be accessed anytime and anywhere, provided you have internet access. This multimedia is also simple to use because it does not need to be downloaded first; just click on the link to access this multimedia.

CONCLUSION

The development of interactive multimedia based on STEM wave material for high school students is declared valid and worthy of trial based on the V Aiken validity value criteria. The validity assessment was carried out by two experts, material experts and media experts, with a media validity score of 0.895 and material validity of 0.826. Thus, the multimedia can be categorized as valid and worth testing.

Suggestions for researchers who want to do similar research are as follows (a) The more experts who review the multimedia, the better the quality of the multimedia (b) it is important to prepare indicators in detail in order to get good validity (c) hoped for the other researchers can continue to the implementation stage.

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