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INTERACTIVE MULTIMEDIA DESIGN BASED ON COGNITIVE CONFLICT USING SMARTPHONE IN MECHANICAL WAVE CHARACTERISTICS

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Abstract :
Almost all students already have a smartphone, but it has not been maximally used for media of learning. This problem was to develop interactive multimedia based on the conflict of cognitive using a smartphone. The study's purpose was to describe the characteristics and produce multimedia of interactive based on a conflict of cognitive that was valid on the material of mechanical wave characteristics. The research conducted was a research of development using the Plomp model. The research procedure consists of preliminary research and development/prototyping phases. This limited research was in the expert review stage. The data collection instruments from this study were the educator's questionnaire sheet, the literature study sheet, the self-evaluation questionnaire sheet, and the validity test sheet. The data analysis techniques used were the percentage technique and the V Aiken technique. In the Develop / Prototyping Phase, interactive multimedia has been designed based on the syntax of the conflict of the cognitive model in learning. The self-evaluation result was obtained with very valid criteria. The validity result of the test obtained an average of 0.77 with a valid category. Therefore, multimedia of interactive based on the conflict of cognitive on mechanical wave characteristics material has been valid in terms of the substance of the material, design of learning, display of visual communication, and utilization of software.

Keywords: Cognitive Conflict; Interactive Multimedia; Mechanical Waves.

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INTRODUCTION

The science development and technology in the 21st century must be adapted to education. Therefore, to achieve the national education objectives, Students must be capable of to adapt to the era of the industrial revolution 4.0 by mastering 21st century known of skills as 4C which consists of “communication, collaboration, creativity, critical thinking and problem solving”. 4C skills are competencies that must be mastered by students to be able to compete in life in the 21st century. Critical thinking skills are needed to find quality learning resources, are objective in assessing so they can compare evidence, are detailed in formulating and are responsible for making decisions (Scott, 2015).

Creativity is considered important because this thinking process can produce innovative solutions to problems found.

One form of science and technology development that is in great demand by students at this time is a smartphone. Smartphone is a mobile phone that has an operating system like a computer. The advantage of smartphones is that they have high mobility and can be operated more effectively (Ismanto, 2017). Smartphones are also easy to carry anywhere and can be used in most environments. Various application features on smartphones make it easier for students to communicate and collaborate, discuss and share learning-related materials (Maknuni, 2020). Given the high use of smartphones by students, teachers should facilitate students using smartphones as media of learning. Kitchenham (2011) states that smartphones are a form of device that can be used as an alternative in developing media. Using smartphones as a learning medium provides opportunities for students to learn more deeply and students can build their competencies in a dynamic way (Rogozin, 2012). However, the high use of smartphones among students is not followed by the use of smartphones as media of learning. Currently, the use of smartphones for students is generally only a communication tool and social media (Ismanto, 2017; Yusra et al, 2023).

Besides being able to adapt to the science development and technology, understanding the concept is also needed to realize the goals of national education in Indonesia, one of which is in physics learning. Physics is a science that studies the nature, phenomena and phenomena in natural and all interactions that are in them. Mastering concepts and principles, as well as having the knowledge and confidence to pursue higher education and advance science and technology, are the learning objectives outlined in the 2013 Curriculum Framework (Kemendikbud, 2014). Understanding this concept is defined as the ability of students to understand, explain or re-express the material they read in their own words and in a simpler form and can implement or apply it in everyday life. Students need to understand the basic concepts and principles that exist in learning in order to understand physics broadly, especially the characteristics of mechanical waves (Saputri, 2021). The success of students in physics learning is seen from the concepts understanding that can be achieved (Arifin, 2020).

In fact, concept understanding of students ability in physics learning at school is still low, especially in the matter of mechanical wave characteristics. The problem that often occurs in physics learning is that the concepts understanding understood by students does not always match the actual concepts called misconceptions (Pratama, 2021). The phenomenon of misconceptions occurs in almost every level of education (Mufit & Festiyed, 2018). Misconception is the application of scientific theories that conflict with those put forth by professionals or scientists whose work has received scientific consensus. (Mufit & Fauzan, 2019). Misconceptions were found in the material of mechanical wave characteristics through a literature review and the results obtained were 22.5% students who understood the concept, 14 students who did not understand the concept, 7% and students who experience misconceptions are 62.8% (Sufiani, 2019). Meanwhile, according to the Widiyanto's research (2018) results, it was found that only 17.7% of students understood the concept, 35.3% of students did not understand the concept and as many as 47.0% of students indicated that they had misconceptions. Misconceptions can hinder learning progress and must be known and remedied from an early age, especially misconceptions in basic physics, if not overcome, it will make it difficult for students to understand advanced physics concepts. For this reason, it is necessary to take remediation actions or the healing process for the misconceptions that occur. 3% of students do not understand the concept and as many as 47.0% of students are indicated to have misconceptions. Misconceptions can hinder learning progress and must be known and remedied from an early age, especially misconceptions in basic physics, if not overcome, it will make it difficult for students to understand advanced physics concepts. For this reason, it is necessary to take remediation actions or the healing process for the misconceptions that occur. 3% of students do not understand the concept and as many as 47.0% of students are indicated to have misconceptions. Misconceptions can hinder learning progress and must be known and remedied from an early age, especially misconceptions in basic physics, if not overcome, it will make it difficult for students to understand advanced physics concepts. For this reason, it is necessary to take remediation actions or the healing process for the misconceptions that occur.

According to the results of a preliminary study on January 15, 2022, through the distribution of Physics learning questionnaires to 2 teachers of SMAN 1 X Koto, it is known that the cause of students' low understanding of concepts in mechanical wave characteristic material is teacher-centered learning

so that students are less involved in finding concepts, the unavailability of special multimedia in learning and have not used certain learning models to overcome concept understanding problems Students on Learning. This is in accordance with the research conducted by Puspitasari (2021) which said that the low understanding of students' concepts was due to the lack of discussion and experiment activities that actively involved students. In addition, there are no IT-based materials of teaching that support student learning activities in online learning. Mufit (2020) also explained that students' ability to understand concepts was still low due to the fact that the learning applied was still teacher-centered.

Prastowo (2011) states that materials of teaching are all items (including texts, tools, and information) that are systematically arranged to show a full range of competencies that students will be expected to master. In order to plan and research how learning is implemented, materials of teaching are used during the learning process. One type of non-printed materials of teaching is multimedia interactive. Multimedia interactive is a combination of images, videos, animations, and sounds in one software (software) that allows users to interact directly which can make students interested in lessons and can increase student interest in learning (Kurniawati, 2018). According to Daryanto (2013) multimedia interactive could be a mixed media that's prepared with a control apparatus that can be worked by the client, so that clients can select anything they need for the another handle. Meanwhile, according to Munir (2013) multimedia interactive is a multimedia display designed by designers so that the appearance fulfills the function of informing messages and has interactivity to its users. The advantage of interactive multimedia is to create enthusiasm, cause attraction and interaction between teachers and students so that students can obtain material with focus and accuracy (Ardini &; Mufit, 2022; Astalini et al, 2023). This multimedia can be opened using a smartphone without an internet network so that students can also use smartphones as learning media. Multimedia interactive has advantages in learning (Septian, 2019). Multimedia interactive can also improve concept understanding of students (Gunawan, 2019; Divine, 2021). Yulianci (2017) also states that the use of multimedia interactive is proven to improve students' understanding of physics concepts better than classes that do conventional learning.

Multimedia interactive materials of teaching were developed using a conflict of cognitive model of learning. The main essence of the conflict of cognitive-based model of learning is that it is based on conflict of cognitive strategies as a trigger for the emergence of conceptual change, in addition to the discovery process that students must do in this model (Mufit & Fauzan, 2019; Prambanan et al, 2023; Ramadhanti, & Simamora, 2023). The conflict of cognitive -based learning show comprises of four syntaxes, to be specific (1) actuation of previously established inclinations and misguided judgments, (2) introduction of cognitive clashes, (3) revelation of concepts and likenesses, (4) reflection (Mufit & Fauzan, 2019). At the concept discovery stage, students can obtain it through experiments conducted through virtual laboratories. The third syntax of this learning model can revise the concept of students' physics learning concepts from misunderstandings or misconceptions they experience (Adha & Mufit, 2021; Hadi et al, 2021; Junaidi & Fadillah, 2022; Fitriani et al, 2023). Conflict of cognitive-based model of learning can move forward concepts understanding and remediate students' misguided judgments and can increment students' information more profoundly (Mufit & Fauzan, 2019; Mufit & Puspitasari, 2020; Fitri & Mufit , 2022).

Based on the description above, to improve students' concepts understanding on the material of mechanical wave characteristics, IT-based materials of teaching are needed in the form of multimedia interactive using smartphones to involve students in learning and avoid misconceptions in physics learning. Therefore, this study aims to describe the characteristics and produce multimedia of interactive using smartphones based on conflict of cognitive that is valid on the material of mechanical wave characteristics. This interactive multimedia is created with the adobe animate CC 2019 application. Adobe animate CC 2019 is the latest application model from adobe that has been created with this latest version can push the boundaries of animation space with asset warping, layer parenting, layer effects and automatic cycles at each layer. Multimedia is used to get an interactive web with HTML5, CCS3 and javascript code created automatically with a graphical user interface, there does not have to be a programming. This application can also be combined with an adobe photoshop or adobe illustrator with sound in the input with adobe audition, as well as video in the input with adobe premiere. Interactive multimedia created with this application can also be used with smartphones without using an internet network.

RESEARCH METHOD

This research uses development research method (Development/Design Research) with the development model is Plomp development and consists of three phases (preliminary research, development and evaluation). The evaluation consists of 5 stages, namely self evaluation, expert review, one to one evaluation, small goup and field test. However, due to time constraints, this research is only limited to the exper review stage. According to Plomp (2013), development research is needed to design and develop an intervention (such as programs, learning tools and strategies, products and systems) assolutions to complex research problems and advances science. This research is limited by the following restrictions:1). interactive multimedia created based on cognitive conflict-based learning models, 2). creation of interactive multimedia based on cognitive conflict developed using the Plomp model that was limited to validity tests

At the preliminary research stage, a needs analysis and literature review were carried out. Needs analysis was carried out on teachers in schools through questionnaires and journal literature studies which aimed to find out the needs and problems that occur in physics learning in schools. The literature review is carried out on reading sources to provide solutions to problems that occur in physics learning at school. In the development and prototype phase, there are 2 stages, namely prototype design and evaluation and revision of the prototype. In the prototype design, multimedia of interactive development is carried outbased on conflict of cognitive to improve the concepts understanding of high school students on the material characteristics of mechanical waves. After the product is finished, it is evaluated and revised through 2 stages, namely self-evaluation and expert review. Self-evaluation was carried out by the researchers themselves and expert reviews were carried out by experts, namely three physicists from the Faculty of Mathematics and Natural Sciences, UNP to assess the validity of the products developed. The validated aspects include content, presentation, language appropriateness, and graphic feasibility in multimedia of interactive based on conflict of cognitive. The research stage chart is shown in Figure 1.

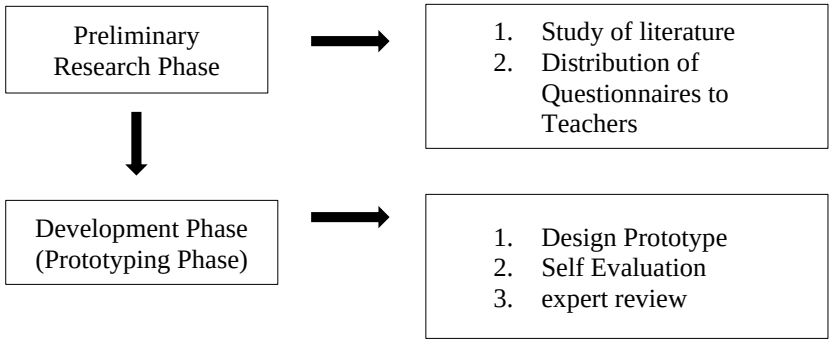

Figure 1. Research Stage

The instrument used in the preliminary research is a questionnaire and for product assessment using a validity assessment instrument. The data analysis technique used in the needs analysis uses equation 1:

$$P = \frac{\sum x}{\sum xi} x100\% = ... \quad (1)$$

Information:
P = Percentage
X = Score obtained
Xi = Total score

The assessment results of the experts were analyzed using the validity test. PValidity test scores were obtained from the validity sheet checklist data compiled using a Likert scale, the Likert scale was used to measure attitudes, opinions and perceptions of a person or group (Budiaji, 2013). Before conducting the validity test by the expert, the researcher conducted a self-evaluation first. The self-evaluation results were analyzed using Equation 1. The provisions of the Likert scale used are: (1) score

1 if the assessment strongly disagrees, (2) score 2 if the assessment disagrees, (3) score 3 if the assessment is neutral, (4) score 4 if the assessment agrees, (5) score 5 if the assessment strongly agrees (Retnawatai, 2016).

The data obtained through the assessment based on the Likert scale were analyzed using the validity index proposed by Aiken. The analysis of the validity of the Aiken's V (V) index item is formulated in Equation 2 and Equation 3.

$$V = \frac{\sum s}{n(c-1)} \qquad (2)$$

$$S = r - l0 \qquad (3)$$

Where V is the index of rater agreement, l0 is the lowest number of validity assessments (in this case = 1), c is the highest number of validity assessments (in this case = 5), r is the number given by a rater and n is the number of raters . After obtaining the rater agreement index, the category of the index value is decided. The category decisions results based on Aiken's V Index are: (1) the category is not valid if the value of 0.4; (2) the category is valid if the value is 0.4 < V 0.8; (3) the category is very valid if the value is > 0.8 (Retnawati, 2016).

RESULTS AND DISCUSSION

Based on the research that has been done, the results obtained in the form of multimedia of interactive based on conflict of cognitive to improve understanding of high school students' concepts on the material of mechanical wave characteristics. The research results based on the research stages are as follows:

Preliminary research stage

At the preliminary research stage, research results were obtained in the form of needs analysis and literature review. In the needs analysis conducted on the teacher and analyze the concept understanding of students through journal articles. The needs analysis results of teachers show that (1) (1) teachers more often use direct learning models in explaining material or teacher-centered which causes lack of mastery of the material in students and students also lack critical thinking, (2) teachers rarely identify student misconceptions (concepts), (3) teachers have not used special learning models in overcoming student misconceptions, thus hindering the process of receiving and organizing new knowledge in students in the process of further learning (4) Interactive multimedia is not yet available which causes students to be less interested in following learning which is considered monotonous. This is in accordance with research conducted by Mufit (2020) on preliminary research that develops physics learning by integrating new literacy and disaster literacy where there is still a lack of understanding of student concepts caused by teacher-centered applied learning. As well as research conducted by Sufiani (2019) on the analysis of students' understanding of physics concepts which states that students have wrong preconceptions that are not known by teachers caused by teachers to emphasize more so that students memorize formulas more and can do many problems, and there has been no effort made by teachers to reveal misconceptions experienced by students before and during classroom learning.Furthermore, the results of the analysis of students' concept understanding are shown in Table 1.

Table 1. Results of Analysis of Student Concept Understanding

Writer	Draft	Misconception %
Sufiani, et al., 2019	Factors that affect the speed of wave propagation	81.4
	Period of traveling wave	63.4
	Frequency of traveling wave	51.4
	Frequency on a stationary wave	48.6
	The wavelength of a stationary wave	69.9
Widiyanto, et al., 2018	Types of waves	41.2
	The relationship between wavelength, speed of propagation and frequency in a string wave	35.3
	Interpretation of amplitude and frequency in sound waves	47.0
	The disconnection of the fast propagation of the rope with the hand motion of the vibrating rope	47.0
	Fast connection of rope propagation with rope tension	41.2
	Direction of wave propagation	11.8

The analysis results of concept understanding of students were obtained from the analysis of two journals on the material of mechanical wave characteristics. The percentage results of students understanding concepts, misconceptions and not understanding concepts, respectively, are in the range of 17.7 - 22.5; 47.0 - 62.8; 14.7 - 35.3. The percentage of students who experience misconceptions and do not understand the concept is greater than students who understand the concept.

Development Phase (Prototyping Phase)

Design Prototype

At the prototype stage, multimedia of interactive has been designed using a smartphone to improve the understanding of high school students' concepts on the material of mechanical wave characteristics. Multimedia of interactive is structured based on the syntax of the conflict of cognitive-based model of learning which consists of 4 syntaxes, namely activation of preconceptions and misconceptions, presentation of conflict of cognitive, discovery of concepts and similarities and reflection. This multimedia of interactive was created using the Adobe Animate CC 2019 application, which is an update of the Adobe Flash application. This application can be used on smartphones without using the internet network. This multimedia of interactive was developed based on the guidance of ICT-based materials of teaching.

Design of the activation and preconception stages. At the activation stage of preconceptions and misconceptions, 5 events related to the material characteristics of mechanical waves are given. The event is about the understanding of mechanical waves, transverse and longitudinal waves, the magnitude of mechanical waves and the application of mechanical waves in everyday life. In each event, several statements are given, students are asked to determine whether the statement is true or false and at the end the students' answers results will be displayed whether they are classified as understanding the concept, misconception or not understanding the concept, so that the teacher can provide the appropriate next action for students. The display of the activation and preconception stages shown in Figure 2.

Figure 2. Praconception and Misconception Activation Stage Design

Design stage presentation of conflict of cognitive.At the stage of presenting conflict of cognitive, 4 questions related to the material characteristics of mechanical waves are given. In each question, phenomena related to mechanical waves are shown in the form of images or videos, such as waves on a rope/slinky and water waves. Students are asked to predict through hypotheses the temporary answer of a given physical phenomenon. This stage can bring up conceptual conflicts in students and can trigger students' curiosity so that students can find new concepts about the material characteristic of mechanical waves. The display of the conflict of cognitive presentation stage shown in Figure 3.

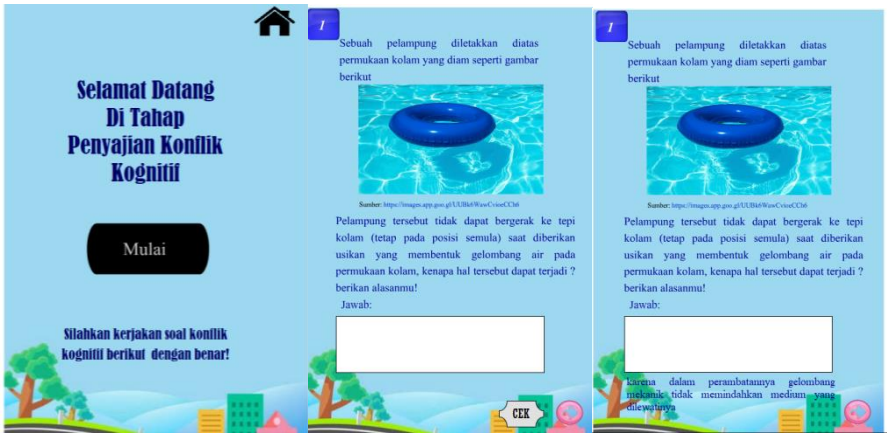

Figure 3. Conflict of cognitive Presentation Stage Design

The design stage of the discovery of concepts and equations. At stagethe discovery of concepts and equations obtained by students through video analysis and experiments using phet simulation wave on a string. In the first stage, students were asked to analyze the 2 videos given, namely a video of a ribbon tied to a rope wave and a slinky that forms transverse and longitudinal waves. By analyzing the video, it is expected that students can understand the meaning of mechanical waves, types of mechanical waves and the application of mechanical waves in everyday life. Meanwhile, to find out the magnitude and relationship of each quantity on a mechanical wave, the students obtained through experiments using phet simulation wave on a string. In phet students can set the value of frequency, period, amplitude, damping and tension in the string wave. Students are asked to write down the experimental results in the data table provided so that students can find out the relationship of each quantity on a mechanical wave using a graph. The display of the concept and equation discovery stage shown in Figure 4.

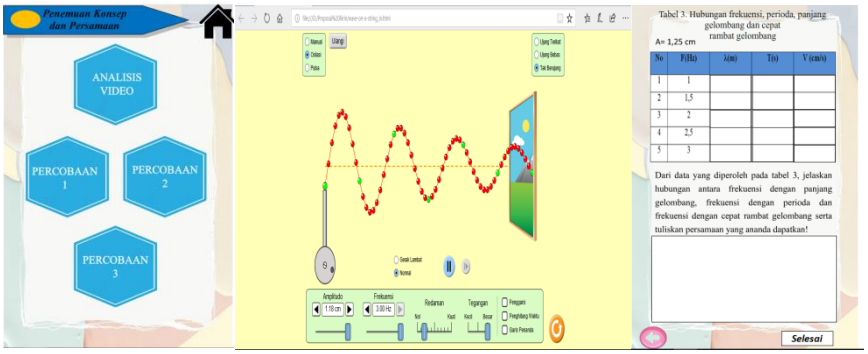

Figure 4. Concept and Equation Discovery Stage Design

Reflection stage design. At this stagestudents are asked to answer 10 multiple choice questions that have been provided regarding the material characteristics of mechanical waves. Students will get 10 points if the answer is correct and 0 points if the answer is wrong on each question. Furthermore, it will show the number of points that have been successfully obtained by students so that students can find out whether they have understood the material of mechanical wave characteristics well or not. If the student's score is low, students will be asked to re-understand the material and repeat the evaluation questions given until they get a satisfactory score. The display of the reflection stage shown in Figure 5.

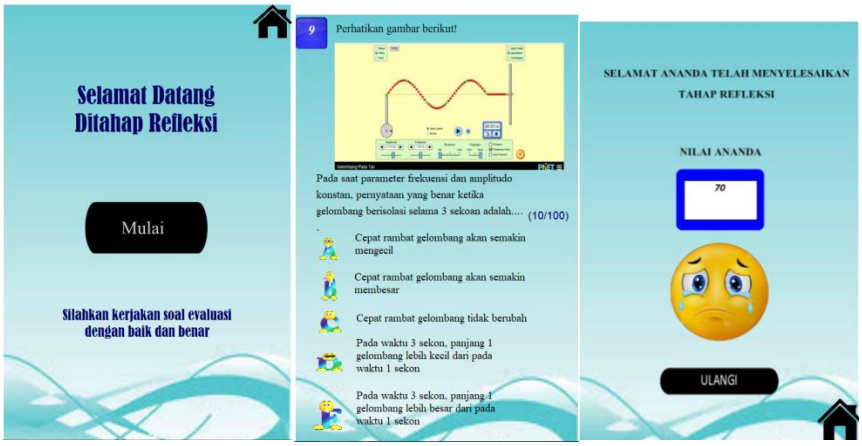

Figure 5.Concept and Equation Discovery Stage Design

Formative evaluation and prototype revision

Self-Evaluation

The self-evaluation assessment results were carried out by the researchers themselves with the aim of re-examining the multimedia of interactive based on conflict of cognitive that the researchers had made. At this self-evaluation stage, the researcher corrected things that were not good, such as improving the navigation buttons from not being clickable to being easy to click, checking the completeness of the prototype, and adding parts that were lacking from the provisions of ICT-based materials of teaching. There are six indicators on self-evaluation, namely the multimedia of interactive structure in accordance with the guidelines for developing ICT-based materials of teaching, multimedia of interactive in accordance with the PBKK model syntax, multimedia of interactive has integrated a virtual laboratory, language, display, and use of software. The self-evaluation results shown in Figure 6.

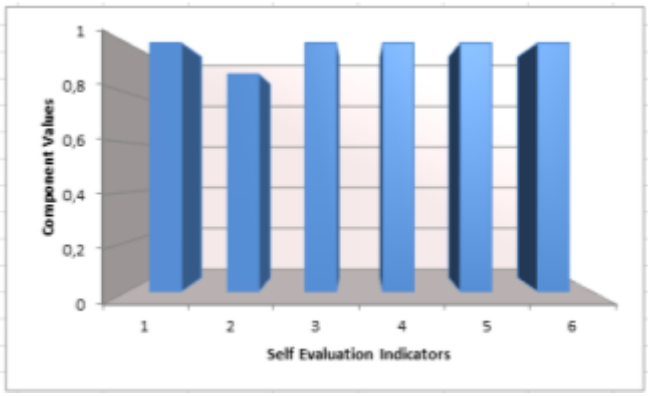

Figure 6. Results of Self-evaluation

Figure 6 shows that the indicator values in the self-evaluation of 6 indicators, 5 indicators have the same value, namely 1 which is classified as all indicators is very valid, while indicator 2 has a value ranging from 0.875. The average value on the self-evaluation indicator is 0.98. Thus, the self-evaluation value is included in the very valid category. This is because multimedia of interactive based on conflict of cognitive has been compiled based on the completeness of the components of ICT-based materials of teaching consisting of titles, study instructions, competencies to be achieved, supporting information, tasks (exercise), work steps, and assessment (evaluation) and compiled with a conflict of cognitive - based model of learning in which there are 4 syntaxes, namely activation of preconceptions and misconceptions, presentation of conflict of cognitive, discovery of concepts and equations as well as reflection. Conflict of cognitive-based model of learning can improve concepts understanding and remediate students' misconceptions and can increase students' knowledge more deeply (Mufit & Fauzan, 2019).

Expert Review

At this stage, a validity assessment has been carried out by experts on the multimedia of interactive based on conflict of cognitive to improve conceptual understanding of high school students on the mechanical wave characteristics material that has been developed for indicators of material substance, design of learning, display of visual communication, and utilization of software. The assessment results shown as follows.

First, the assessment results of the material substance indicators are obtained for5 assessment components. Among them: 1) The suitability of the material with the 2013 curriculum. 2) The suitability of the material with the Basic Competencies. 3) Conformity of indicator formulation with Basic Competence. 4) Language compatibility with Improved Spelling. 5) Clarity of language. The data plot results on each component contained in the material substance indicator shown in Figure 7.

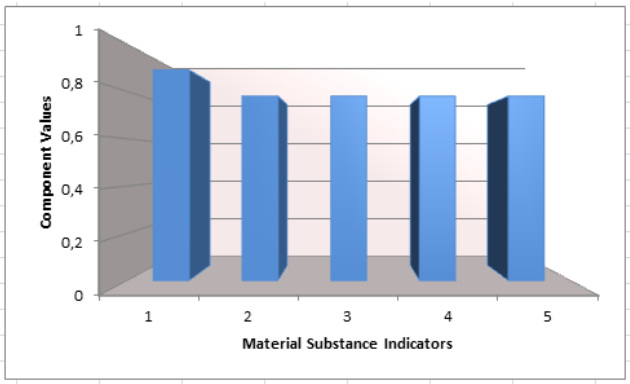

Figure 7. Assessment Results of Material Substance Indicators

Based on Figure 7, it shown that the validation value of the material substance indicator ranges from 0.78 to 0.89. Of the 5 components in the material substance indicator, there is one component that

is classified as very valid and four components that are classified as valid. The average value of the five components of the material substance indicator is 0.80 which is classified as valid. This is because this is because the material presented in multimedia of interactive is in accordance with the 2013 Curriculum, the material presented in multimedia of interactive is in accordance with the basic competencies, namely Basic Competencies 3.8 and 4.8 regarding the characteristics of mechanical waves, the indicators presented in multimedia of interactive are in accordance with the competencies base, Most of the language used in multimedia of interactive is in accordance with Enhanced Spelling and the language used in multimedia of interactive is mostly standard and understandable. The substance of the material must be designed in accordance with the standards of learning objectives that are applied (Khairunnisa et al, 2018).

Second, the assessment results of design of learning indicators were obtained for 13 assessment components, including 1) Multimedia of interactive Title. 2) Listing Core Competencies and Basic Competencies. 3) Conformity of learning objectives with Basic Competencies. 4) Material in interactive multimedia. 5) Preconception and misconception activation stage. 6) Stage of presentation of conflict of cognitive. 7) The stage of finding concepts and equations. 8) Reflection stage. 9) Data literacy. 10) Technological literacy. 11) Human literacy. 12) The identity of the compiler. 13) Citing other people's work. The data plot results of each component in the design of learning indicators shown in Figure 8.

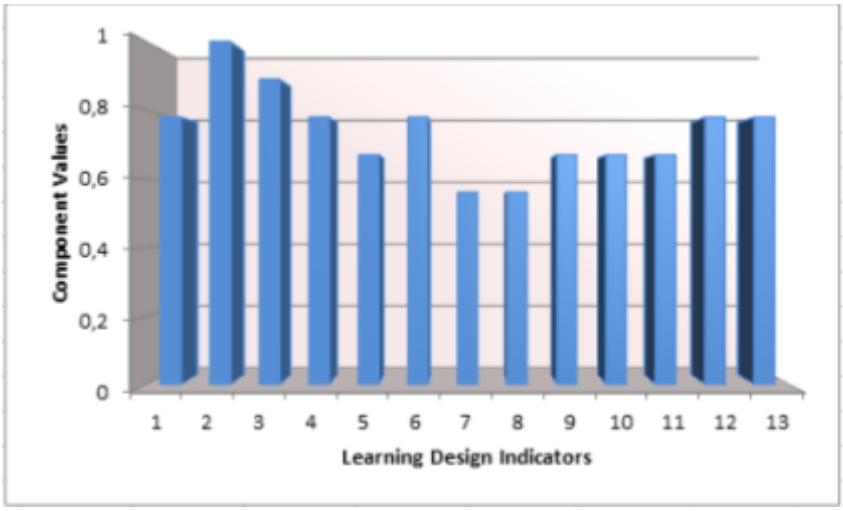

Figure 8. Assessment Results of Design of Learning Indicators

Based on Figure 8, it shown that the validity values for the instructional design indicators range from 0.56 to 1.00. Of the 13 components in this indicator, there are two components that are classified as very valid with a value range of 0.89 to 1 and eleven more components are classified as valid with a validity value ranging from 0.56 to 0.78. The average validation value for the 13 components of the instructional design indicator is 0.74. Thus the value of the validity of the design of learning is valid. This is becausein multimedia of interactive is in accordance with the content of interactive multimedia, core competencies and basic competencies have been included in interactive multimedia, learning objectives in multimedia of interactive are complete and in accordance with basic competencies, material in multimedia of interactive is in accordance with learning objectives. multimedia of interactive has been prepared with a conflict of cognitive -based model of learning in which there are 4 syntaxes, namely activation of preconceptions and misconceptions, presentation of conflict of cognitive, discovery of concepts and similarities and reflection. The characteristics of multimedia of interactive are independent, meaning that they can provide convenience and completeness of contents that are structured in a structured manner so that students can use them without teacher guidance (Mukhaiyar, 2019). Furthermore, there is data literacy in interactive multimedia, entering data and processing data. Human literacy has also been found in multimedia of interactive that gives rise to communication and collaboration. As well as the identity of the compilers and citations of other people's works that are already contained in the multimedia of interactive material on the characteristics of mechanical waves.

Third, the assessment results of display of visual communication indicators were obtained for 6 assessment components, including: 1) Use of navigation. 2) Use of fonts (type and size) of letters. 3) Use of images, animations and sounds. 4) The combination of colors on the cover and each slide. MI 5)Layouts. 6) Instructions for use. The data plot results of each component in the display of visual communication indicator shown in Figure 9.

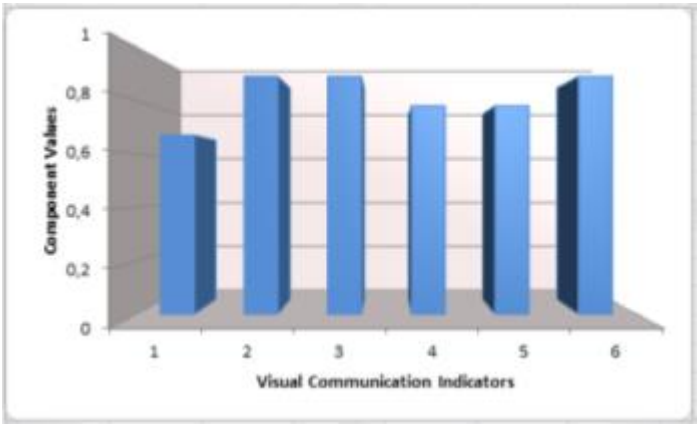

Figure 9. Assessment Results of display visual communication Indicators

Based on Figure 9, the validity value of the visual display indicator ranges from 0.67 to 0.89. In the display of visual communication indicator, there are three components that are classified as very valid with a value range of 0.89 and the other three components are worth between 0.67 to 0.78, which means that these three components are valid. The average value of the 6 components on the display of visual communication indicator is 0.82, which means that the display of visual communication indicator is very valid. This is because multimedia of interactive already uses basic navigation and hyperlinks, fonts in multimedia of interactive are legible and proportional, multimedia of interactive uses images, sound and video as well as clear instructions for use in interactive multimedia.

Fourth, the assessment results on utilization of software indicators are obtained for 3 assessment components, including: 1) Multimedia of interactive is interactive in providing feedback to users. 2) Multimedia of interactive using supporting software. 3) Multimedia of interactive is an original work. The data plot results for this indicator are shown in Figure 10.

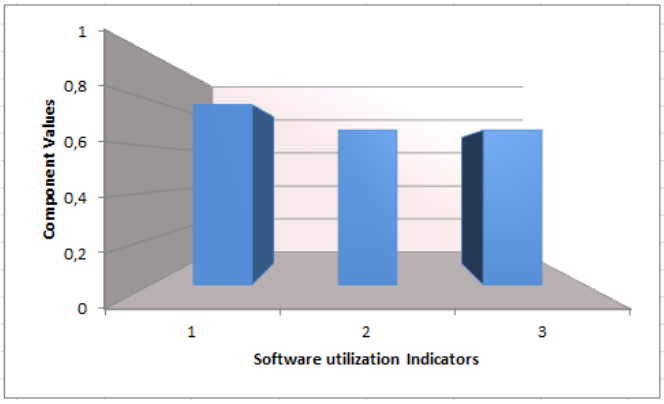

Figure 10. Assessment Results of Utilization in Software Indicators

Based on Figure 10, it shown that the validation results on the utilization of software indicators are in the value of 0.67 to 0.78. The average value of the 3 components on the utilization of software indicator is 0.72, which means that this indicator is valid. This is because there is already feedback at the learning stage, already utilizing supporting software in the process of making multimedia of interactive and multimedia of interactive which is almost completely made by themselves.

Based on four indicators consisting of material substance, design of learning, display of visual communication and utilization of software, there is an multimedia of interactive assessment based on

conflict of cognitive to improve concept understanding of students of the material characteristic of class XI mechanical waves. The average results of the data plots for the four indicators shown in Figure 11.

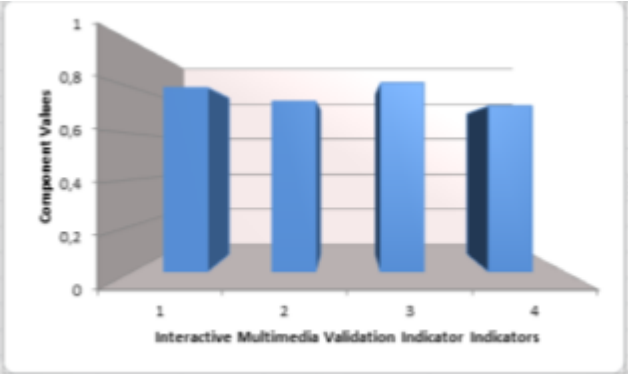

Figure 11. Multimedia of interactive Validation Results

Based on Figure 11, it shown that the multimedia of interactive validation results have values of 0.80, 0.74, 0.82, and 0.72. From the four indicator values obtained, the average value is 0.77, which means that multimedia of interactive based on conflict of cognitive is valid. This is in accordance with the research conducted by Dhanil (2021) regarding the development of multimedia of interactive based on conflict of cognitive on static fluid material which is included in the valid category. As well as research conducted by Arifin (2021) on multimedia of interactive based on conflict of cognitive on thermodynamic material and mechanical waves which are included in the valid category. The advantage of this research is that it uses the latest application, namely adobe animate cc 2019, where this application can make the display of multimedia of interactive materials of teaching more varied, not only text, images, videos, and audio can also be inserted in this media so that the learning process will be more interesting . In addition, this application can also be used on smartphones without using the internet network. This interactive multimedia can increase students' attractiveness to learn mechanical wave material thereby increasing students' understanding of concepts and remediating misconceptions experienced by students on mechanical wave material. Because valid interactive multimedia has been produced, other researchers can continue the practicality and effectiveness stage of this interactive multimedia so that it can be used to increase students' attractiveness to study mechanical wave material so as to increase students' understanding of concepts and mediate misconceptions experienced by students towards mechanical wave material.

CONCLUSION

Multimedia of interactive based on conflict of cognitive on the material of mechanical wave characteristics has been produced with the following characteristics. multimedia of interactive consists of title components, competency standards and basic competencies, indicators of competency achievement, materials, practice questions, competency tests and references. Multimedia of interactive is structured based on 4 syntaxes of conflict of cognitive-based model of learning, namely activation of preconceptions and misconceptions, presentation of conflict of cognitive, discovery of concepts and similarities and reflection. The third stage is the discovery of concepts and equations to integrate the virtual laboratory. The multimedia of interactive validation results based on conflict of cognitive on the material of mechanical wave characteristics obtained from experts are categorized as valid. The characteristics of product validity are material substance, design of learning, display of visual communication and utilization of software. This interactive multimedia is created using the latest Adobe Animate CC 2019 which has many new features application and can be used using a smartphone without an internet network (offline). Because valid interactive multimedia has been produced, other researchers can continue the practicality and effectiveness stage of this interactive multimedia so that it can be used to increase students' attractiveness to study mechanical wave material so as to increase students' understanding of concepts and mediate misconceptions experienced by students towards mechanical wave material.

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