# DEVELOPMENT OF INTERACTIVE MULTIMEDIA BASED ON COGNITIVE CONFLICT TO IMPROVE UNDERSTANDING CONCEPTS AND SKILLS OF 4C STUDENTS ON ELASTICITY AND HOOKE'S LAW MATERIAL

**SONIA FITRI ANGGRAINI**
17033069/2017

**PHYSICS EDUCATION OF STUDY PROGRAMS**
**DEPARTMENT OF PHYSICS**
**FACULTY OF MATHEMATICS AND NATURAL SCIENCE**
**UNIVERSITAS NEGERI PADANG**
**2021**

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**UNDERGRADUATE THESIS**

*Submitted as Partial Fulfillment of Requirements to Obtain the Strata One (S1) Degree*


**By**

**SONIA FITRI ANGGRAINI**
17033069/2017

**PHYSICS EDUCATION OF STUDY PROGRAMS**
**DEPARTMENT OF PHYSICS**
**FACULTY OF MATHEMATICS AND NATURAL SCIENCE**
**UNIVERSITAS NEGERI PADANG**

**2021**

## UNDERGRADUATE THESIS APROVAL

| | |
|---|---|
| Title | : Development Of Interactive Multimedia Based On Cognitive Conflict To Improve Understanding Concepts And Skills Of 4C Students On Elasticity And Hooke's Law Material |
| Name | : Sonia Fitri Anggraini |
| Student Id | : 17033069 |
| Study Program | : Physics Education |
| Department | : Physics |
| Faculty | : Mathematics and Natural Science |

Padang, 02 November 2021

Approved by:

Head of Department

**Dr. Ratnawulan, M.Si**
Nip. 19690120 199303 2 002

Advisor

**Dr. Fatni Mufit, S.Pd, M.Si**
Nip. 19731023200012202

**PASS RATIFICATION OF THE THESIS EXAMINATION**

| | |
|---|---|
| Name | : Sonia Fitri Anggraini |
| Student ID | : 17033069 |
| Study Program | : Physics Education |
| Department | : Physics |
| Faculty | : Mathematics and Natural Science |

**Development Of Interactive Multimedia Based On Cognitive Conflict To Improve Understanding Concepts And Skills Of 4C Students On Elasticity And Hooke's Law Material**

It was declared that he had passed after being defended in front of the Thesis Examinier Team for the Department of Physics, Faculty Of Mathematics and Natural Science, Universitas Negeri Padang

Padang, 02 November2021

Testing Team

| | | Name | | Signature |
|---|---|---|---|---|
| 1 | Chairman | Dr. Fatni Mufit, S.Pd, M.Si | 1. | |
| 2 | Member | Drs. Gusnedi, M.Si | 2. | |
| 3 | Member | Drs. Letmi Dwiridal, M.Si | 3. | |

## STATEMENT LETTER

Hereby declare that:

1. My writing, the final project in the form of a thesis with the title " Development of Interactive Multimedia Based On Cognitive Conflict to Improve Understanding Concepts and Skills of 4C Students On Elasticity and Hooke's Law Material" is the result of my own work.
2. This paper is purely my own ideas, formulations and research, without any help from other parties except from the supervisor.
3. In the writing of this paper, there are no opinions or works that have been written and published by others, except in writing that is clearly stated as a reference in the manuscript, mentions the author and is included in the literature.
4. I make this statement in truth and if there are deviations in this statement, I am willing to accept academic sanctions in the form of revocation of the degree that I have obtained, as well as other sanctions in accordance with applicable norms and provisions.

Padang, November 2, 2021

Who make the statement


Sonia Fitri Anggraini
17033069

# ABSTRACT

**Sonia Fitri Anggraini: Development of Interactive Multimedia Based On Cognitive Conflict to Improve Understanding Concepts and Skills of 4C Students On Elasticity and Hooke's Law Material**

21st-century learning demands the competence of students to have 4C skills (communication, collaboration, critical thinking, and creativity). Besides that, in learning physics, students also need to understand the principles and concepts of physics as one of the objectives in the 2013 curriculum. The fact is that in the field, students' understanding of concepts and 4C skills is relatively low, including elasticity and Hooke's law. One solution to this problem is to develop interactive multimedia based on cognitive conflict as an effort to improve students' understanding of 4C concepts and skills on elasticity and Hooke's law. The purpose of this study was to determine the characteristics, validity, practicality, and effectiveness of interactive multimedia at the small group stage.

This research is a Development/Design Research using the Plomp development model. The research is limited to the Develop or Prototyping Phase, that is, to small group trials. The object of this research is interactive multimedia based on cognitive conflict. Validity data were obtained from three experts who are physics lecturers at the Faculty of Mathematics and Natural Sciences UNP, the results of practicality and effectiveness were obtained from class XI students of SMAN 13 Padang in the one-to-one and small group stages. The data collection instruments in this study were validation instrument sheets, practical instrument sheets, and effectiveness instrument sheets in the form of concept test sheets and 4C skill sheets. The technique used to analyze the validity and product data is using V Aiken, the practicality of the product is using the percentage technique, and the effectiveness of understanding the concepts and skills of 4C using the Wilcoxon test.

Based on the needs analysis in the preliminary research, an interactive multimedia product is produced with the characteristics: consisting of 4 cognitive conflict-based learning model syntax, integrating 4C skills made using the adobe animate CC 2019 application. The self-evaluation results were obtained with very good criteria. The results of the validity test were obtained with an average of 0.79 which was in the valid category. The practical results at the one-to-one and small group stages are in the very strong or very practical category with values of 0.89 and 0.83 respectively. The use of interactive multimedia based on cognitive conflict can improve students' understanding of 4C concepts and skills at the small group stage. So, it can be concluded that interactive multimedia based on the cognitive conflict on elasticity and Hooke's law is valid, practical, and effective in improving students' understanding of 4C concepts and skills at the small group stage.


Keywords: Interactive multimedia, cognitive conflict, misconceptions, elasticity, and Hooke's law.

# ACKNOWLEDGMENT

The writer would like to thank Allah SWT who has bestowed His mercy and grace so that the writer can finish this thesis. The title of this thesis is "Development of Interactive Multimedia Based On Cognitive Conflict to Improve Understanding Concepts and Skills of 4C Students on Elasticity and Hooke's Law Material". Shalawat and greetings go to the Prophet Muhammad SAW. This thesis is also prepared to fulfill one of the requirements in obtaining a bachelor's degree in Physics Education at the Faculty of Mathematics and Natural Sciences UNP. The author in carrying out the preparation and completion of this thesis has received a lot of guidance, motivation, input, and instructions from various parties. For this reason, the author would like to thank:

1. Mrs. Dr. Fatni Mufit, S.Pd, M.Si academic supervisor and thesis supervisor as well as Secretary of the Department of Physics, FMIPA UNP, who has motivated and guided the author in planning, implementing, and reporting the results of this research and being an expert who validates conflict-based interactive multimedia. cognitive skills to improve students' understanding of 4C concepts and skills on elasticity and Hooke's law.
2. Mr. Drs. Gusnedi, M.Si as examiner lecturer and expert who validates interactive multimedia based on cognitive conflict to improve students' understanding of 4C concepts and skills on elasticity and Hooke's law.

**3.** Mr. Drs. Letmi Dwiridal, M.Si as examiner lecturer and expert who validates interactive multimedia based on cognitive conflict to improve students' understanding of 4C concepts and skills on elasticity and Hooke's law.

4. Mrs. Dr. Riri Jonuarti, S.Pd, M.Si as an expert who validates interactive multimedia based on cognitive conflict to improve students' understanding of 4C concepts and skills on elasticity and Hooke's law.

5. Mrs. Dr. Ratnawulan, M.Si as the Head of the Physics Department as well as the Head of the Physics Education Study Program, FMIPA UNP.

6. Mr. and Mrs. Lecturer Staff of the Department of Physics, Faculty of Mathematics and Natural Sciences, UNP, who have provided the author during the lectures until the end of writing this thesis.

7. Administrative staff of the Department of Physics, Faculty of Mathematics and Natural Sciences, UNP, who has helped the author during the lectures and writing of this thesis.

8. Mr. Zahroni, M.Pd as Principal of SMAN 13 Padang.

9. Mrs. Nurtina J, S.Pd as a physics teacher at SMAN 13 Padang who has given permission for research in class XI MIPA 2.

10. Mr and Mrs Lecturer Staff of SMAN 13 Padang.

11. Class XI MIPA 2 SMAN 13 Padang students who have contributed to this research.

12. Parents for their services, patience, prayers and never tired of educating and giving sincere and sincere love to the author since childhood.

13. Members of the research team who always give encouragement and encouragement to the author.

**14.** All parties who have assisted in the preparation and completion of this thesis report.

15. Hopefully all the guidance, help and attention that has been given to the author will be a good deed to all and get a double reward from Allah SWT. The author expects suggestions and criticisms to improve this thesis. Hopefully this thesis is useful for readers.

Padang, August 2021

Writer

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# CHAPTER I
# INTRODUCTION

## A. Background of The Research Problem

The important role of education can produce quality Human Resources (HR) because human education can change behavior for the better by humanizing humans and being able to adapt to the times. Quality humans are humans who are superior in terms of attitude, spiritual, intellectual, social, and performance. According to Law of the Republic of Indonesia No. 20 of 2003, it is explained that education is a conscious effort in the learning process that allows students to develop their potential in terms of religion, self-control, personality, intelligence, noble character, and skills in themselves. The function of national education is to educate the nation's life, the goal is that students become human beings who believe and fear God Almighty, have a noble character, are healthy, knowledgeable, capable, creative, independent, and responsible. To achieve the goals of education, a curriculum is needed.

The curriculum is a set of plans that regulate the content and learning materials as a guide in implementing learning to achieve national education goals (Hamalik, 2003). In realizing good education, the curriculum used must be good. In Indonesia, there have been frequent changes to the curriculum. One of the reasons the government developed the curriculum was because the results of the PISA (Program for International Student Assessment) students in the science field tended to experience a decrease in literacy scores (OEDC, 2019). Looking at the results of Indonesia's assessment at the international level, it is hoped that Indonesian education

can improve itself. The Ministry of Education and Culture has made improvements to the primary and secondary school curriculum. The curriculum used previously was the Competency-Based Curriculum (KBK), which was later changed to the Education Unit Level Curriculum (KTSP), until finally refined into the 2013 Curriculum (K-13).

The 2013 curriculum is currently used in the Indonesian education system with one of its demands, namely student-centered learning, the goal is that students can adapt to 21st-century learning by having 4C skills (communication, collaboration, critical thinking, and creativity) (Permendikbud 2017). 4C skills can be defined as follows: (1) Communication is a communication skill to convey ideas, ideas, information, or knowledge to others both orally and in writing so that it can be understood by others, it is necessary to have good communication skills. (2) Collaboration is the skill of working together effectively, synergizing with each other, participating among several people, groups, and organizations, and being responsible within groups or organizations for achieving common goals. (3) Critical Thinking (critical thinking) is a skill to solve a complex problem by finding a solution to the problem. (4) Creativity is the ability to discover, develop, and convey new things to others that have never existed before.

The 2013 curriculum is also used in physics learning. One of the objectives of learning physics in the 2013 curriculum is that students can understand concepts and principles and have skills in developing knowledge and self-confidence as a provision to continue education at a higher level and can develop science and technology (Permendikbud, 2014). Based on these objectives, learning physics must be a means

or vehicle for mastering knowledge, understanding concepts, and principles in physics. In addition, based on the 2013 curriculum, teachers are not the only source of learning but learn using many sources (based on various learning resources), learning is carried out using a scientific approach with a certain model, and utilize information and communication technology to improve the efficiency and effectiveness of learning (Permendikbud, 2014). Therefore, based on the demands that have been set, teachers are expected to develop interesting, creative, and innovative teaching materials (Zuriah, 2016). The teaching materials developed can be technology-based.

One form of technology-based teaching materials is interactive multimedia teaching materials. Interactive multimedia is a teaching material that combines various media in the form of images, videos, and sounds. As well as with interactive multimedia allows interaction between students or users with these teaching materials. Interactive multimedia can make students learn independently, this can encourage students to understand concepts and principles and can improve 4C skills from the learning they do directly. The advantages of learning using interactive multimedia can make students more interested and can streamline student work because students can interact with images, sounds, even videos, and something instant (Utami, 2014). And interactive multimedia can improve students' 4C skills, one of which is critical thinking skills (Djamas et al, 2019). So, the use of interactive multimedia can encourage student-centered learning by the demands of the 2013 curriculum.

The reality on the ground shows that there is a misconception in students, because of the initial knowledge of students obtained from the surrounding environment but not by the opinions of experts. One of the physics concepts that is closely related to everyday life is the concept of elasticity and Hooke's law which is studied by students in class XI Semester 1. The material of elasticity and Hooke's law is also not spared from various other studies that reveal misconceptions. As found in the journals written by Hidayati (2016) and Nisa (2019), on the subject of elasticity and Hooke's law, misconceptions occur in the concept of elastic-plastic energy, the concept of Hooke's law, the concept of Young's modulus, and the concept of spring potential energy. Table 1 shows the results of the percentage level of understanding of students' concepts on elasticity and Hooke's law from the results of journal reviews.

Table 1. Percentage of students' concept understanding

| No | Material | Understand Concept | Misconception | Don't Understand Concept |
|---|---|---|---|---|
| 1 | Elastic-plastic energy concept | 42.14% | 49.64% | 8.21% |
| 2 | Hooke's law concept | 55.24% | 38.09% | 6.66% |
| 3 | Young's Modulus Concept | 26.42% | 63.57% | 10% |
| Average | | 40.57% | 51.05% | 8.38% |

(Hidayati, 2016)

Based on Table 1 above, it is known that misconceptions do occur in the elasticity material and Hooke's law in the sub material of the elastic-plastic energy concept of 49.64%, the concept of Hooke's law of 38.09%, and the concept of

Young's modulus of 63.57% (Hidayati, 2016). ). So that the average of students' understanding of concepts is 40.57%, students' misconceptions are 51.05% and do not understand are 8.38%. And from the research that has been done by (Nisa S, L. et al 2019) it was found that the magnitude of students' understanding of the concept of elasticity and Hooke's law was 56.2%, misconceptions that occurred in students in this material were 25.7% and not understand that is 18.1%. In related journals, several causes of misconceptions were also found, namely students' understanding of the concept of elasticity is not scientifically appropriate but their understanding is by every day life terms (Mustofa Z, 2018 and Nisa SL, et al, 2019). The methods used by teachers in learning use conventional methods or lectures (Hidayati, 2019 and Prastowo, et al, 2017), causing the learning process to be teacher-centered and students cannot find new ideas or ideas to develop. Another problem that causes misconceptions to occur in students is the learning resources used (Hidayah, et al, 2020). This causes the learning process to be centered on the teacher and students cannot find new ideas or ideas to develop. Another problem that causes misconceptions to occur in students is the learning resources used (Hidayah, et al, 2020). This causes the learning process to be centered on the teacher and students cannot find new ideas or ideas to develop. Another problem that causes misconceptions to occur in students is the learning resources used (Hidayah, et al, 2020).

From the learning problems obtained from related journals, it turns out that this problem is also found in physics learning at SMAN 13 Padang. The questionnaire given to 3 physics teachers at SMAN 13 Padang aims to find out the learning problems and the level of 4C skills carried out in physics learning, especially on elasticity and Hooke's law.

Table 2. Percentage of Learning Process on Materials of Elasticity and Hooke's Law

| No | Identification of Concept Understanding and Use of Teaching Materials on Elasticity and Hooke's Law Materials | Percentage (%) |
|---|---|---|
| 1 | Emphasis of the material by the teacher | 86% |
| 2 | Direct learning model | 100% |
| 3 | A special model for overcoming misconceptions | 54% |
| 4 | Emphasizing on experimental or experimental activities in finding concepts | 66% |
| 5 | Use of Interactive Multimedia | 46% |

Based on Table 2, the learning problems that occur at SMAN 13 Padang include the emphasis on material by the teacher who is classified as high, causing a lack of emphasis on physics concepts. The learning model used is direct so that students are bored and do not have their ideas in learning. Learning the special model to overcome the misconceptions used is still low. Concept discovery in experimental activities is still low, and the use of interactive multimedia by the demands of the 2013 curriculum is still low.

In addition, from the results of the questionnaire given, it is known that the learning carried out to train students' 4C skills is still relatively low. One of the reasons is that the learning process is still teacher-centered. Other things that indicate that students' 4C skills are still low based on the questionnaire are the low percentage of group discussion results to clarify students' conceptual understanding, low presentation of students to present experimental results, and very rare use of virtual laboratory or phet simulation to find concepts and similarities.

The solution to overcome the problems that the authors found in the materials of elasticity and Hooke's law is to design interactive multimedia teaching materials based on cognitive conflict. Using interactive multimedia can make students not get bored and bored quickly and can provide feedback to students so that students' motivation to learn increases (Sanjaya, 2012). Interactive multimedia is combined with a cognitive conflict-based learning model to improve conceptual understanding (Rahim, 2015). Interactive multimedia contains 4 syntaxes including: (1) activation of preconceptions and misconceptions, (2) presentation of cognitive conflicts, (3) discovery of concepts and similarities, (4) reflection (Mufit, 2018), and integrating 4C skills with the aim of improving conceptual understanding. and students' 4C skills. Interactive multimedia based on cognitive conflict encourages students to find concepts, think critically, think creatively, collaboratively and communicatively in learning. Interactive multimedia based on cognitive conflict can also be used in direct and online learning (blended learning). The interactive nature of this multimedia is

that students can type the desired answer, choose the correct answer, carry out experiments, and students get feedback from activities carried out on interactive multimedia. The advantage of the cognitive conflict-based learning model is that it can remediate misconceptions and can improve students' understanding of concepts. So the purpose of this research is to design interactive multimedia based on cognitive conflict to improve students' understanding of 4C concepts and skills on elasticity and Hooke's law.

**B. Identification of The Research Problems**

Based on the description of the background above, the problems contained in this study are:

1. Students' understanding of 4C concepts and skills is still low on elasticity and Hooke's law material
2. The learning model used by the teacher in the learning process is still dominantly using conventional methods and lectures so that they have not used a specific model to remediate misconceptions
3. Teaching materials specifically to improve understanding of concepts and overcome students' 4C skills are not yet available
4. There is no interesting interactive multimedia to improve concept understanding

**C. Limitation and Scope of The Problem**

Based on the title that has been proposed, this research is limited by the following restrictions:

1. Interactive multimedia based on the syntax of the cognitive conflict-based learning model developed by Mufit F and Fauzan A (2019)
2. Interactive multimedia creation application using Adobe Annimate CC 2019
3. Making interactive multimedia based on cognitive conflict was developed using the Plomp model which was limited to effectiveness testing at the small group stage

**D. Formulation of The Research Problem**

1. What are the characteristics of interactive multimedia design based on cognitive conflict on elasticity and Hooke's law?
2. How is the validity of interactive multimedia based on cognitive conflict on elasticity and Hooke's law?
3. How is the practicality and effectiveness of interactive multimedia based on cognitive conflict on elasticity and Hooke's law?
4. How is the practicality and effectiveness of interactive multimedia based on cognitive conflict on elasticity and Hooke's law to improve students' understanding of 4C concepts and skills?

**E. Purpose of The Research**

Based on the formulation of the research problem, the objectives to be achieved through this research are:

1. Describe the characteristics of interactive multimedia based on cognitive conflict on elasticity and Hooke's law material

2. Knowing the validity of interactive multimedia based on cognitive conflict on elasticity and Hooke's law material
3. Knowing the practicality and effectiveness of interactive multimedia based on cognitive conflict on elasticity and Hooke's law material
4. Knowing the practicality and effectiveness of interactive multimedia based on cognitive conflict to improve students' understanding of 4C concepts and skills on elasticity and Hooke's law up to the small group stage

**F. Product Specifications Produced**

1. The interactive multimedia designed is based on cognitive conflict, which consists of 4 stages of the PbKK model, namely (1) activation of preconceptions and misconceptions, (2) presentation of cognitive conflicts, (3) discovery of concepts and similarities, (4) reflection.
2. Interactive multimedia pays attention to the structure of ICT-based teaching materials.
3. Interactive multimedia integrates a virtual laboratory in the third stage of the cognitive conflict-based learning model
4. Cognitive conflict-based interactive multimedia using the Adobe Animate CC 2019 application

**G. Benefits of Research**

1. For students, to make it easier to understand the concept of elasticity and Hooke's law

2. For teachers, interactive multimedia is an alternative learning resource in improving students' conceptual understanding
3. For researchers, using interactive multimedia based on cognitive conflict can attract students' interest and motivation in understanding the concept of elasticity and Hooke's law
4. Cognitive conflict-based interactive multimedia can be used as an alternative to online learning or blended learning
5. For other researchers, for reference in further research.

# CHAPTER II
# REVIEW OF RELATED LITERATURE

## A. Theoretical study

### 1. The Nature of Physics Learning

Learning is essentially a process of interaction between students and their environment so that it changes for the better (Mulyasa, 2008:255). According to Rusman (2012:116) Learning is a process of integrating components and activities, between students and their environment in order to change behavior for the better. According to RI Law No. 20 of 2003, learning is a process of interaction between educators and students in a learning environment to achieve certain goals.

From some of the opinions above, it can be concluded that learning is a process of integrating a component or activity between educators and students in order to change behavior for the better and can achieve the desired goals.

According to Trianto (2009:137) Physics is a branch of science that was born and developed through the steps of observation, formulation of problems, formulation of hypotheses, hypothesis testing through experiments, and drawing conclusions, which in the end found a concept of physics. In KBBI, physics is the study of nature and its substances, energy and interactions such as heat, light and earth.

The essence of learning science, especially physics, is the existence of observation and experiment activities in a broad sense (Mufit & Fauzan, 2019). The main characteristic of science learning is the interaction between students and educators. According to Cross, studying science is not only to understand scientific

concepts and their applications, but also to develop various values. Science does not only collect knowledge, but in learning science also collects processes. Therefore, in science learning, students must be given the opportunity to develop their curiosity, so that later students can understand things by themselves through the process, and can make conceptual changes (Mufit & Fauzan, 2019).

From the description above, it can be concluded that the nature of learning physics is the interaction that occurs between educators and students, as well as students and the environment that discuss natural sciences and their interactions, in order to change behavior for the better.

**2. Concept Understanding**

According to Arens (2008) the concept is a tool used to organize knowledge and experience into various categories. Concepts can be obtained from direct experience of an event in life. Bruner, Goodnow and Austin argue that a concept is composed of five concepts in the form of names, definitions, attributes, values and examples. The concept emphasizes something that is real and is obtained from relevant experience. Understanding concepts is an important aspect of learning, especially in learning that is close to us such as daily events, one of which is learning physics.

Physics is a learning that prioritizes mastery of concepts, with a good mastery of concepts, physics learning can be mastered well. Mastery of the concepts possessed can make it easier for students to continue learning to a higher level. Because physics is a continuous science, if you have a good understanding of the

concept at the beginning, you will not experience difficulties when studying the next material. This can change the mindset of students who say that physics is an abstract science and difficult to understand.

**3. Physics Misconceptions**

Misconception is an interpretation of concepts in a statement that cannot be accepted because it is not in accordance with the opinions of experts according to Novak & Gowin in (Nadhiif, 2015). Misconceptions are incorrect explanations because they are not scientifically appropriate. So, it can be concluded that misconception is a knowledge that a person has but cannot be accepted by experts because it is not scientifically appropriate. Misconceptions tend to occur from initial knowledge obtained from the environment or daily activities. One of the lessons that are close to everyday life is learning science, including learning physics.

According to Wandarsee, Mintzes and Novak, 1994, conception occurs in all fields of physics. Of the 700 studies on misconceptions, there are 300 researching in the field of mechanics, 159 on electricity, 70 on heat, optics, and the properties of matter, 35 on earth and space and 10 on modern physics. Misconceptions in the field of mechanics are widely studied because the field of mechanics is the starting material in high school or college.

According to Wilardjo (2009, in Mufit, 2018) "students' skills in changing the mathematical form of formulas that state the laws of physics and their agility use these formulas to solve problems and quantitative questions can hide their

misconceptions about the law. that ". So although students can solve physics problems qualitatively, qualitatively they do not understand the laws of physics.

Most students only memorize the formula or equation. This misconception phenomenon occurs in almost every level of education, even according to Wilardjo (2009, in Mufit, 2018), although the number of students who experience misconceptions tends to decrease with increasing age and the higher their age they still suffer from misconceptions until college even after becoming a graduate. .

**4. Misconceptions on Elasticity and Hooke's Law**

Misconceptions on elasticity and Hooke's law are also physics materials that students have misconceptions about. As seen in the research conducted by Hidayati (2016) and Nisa (2019), the sub-materials that become misconceptions in the material of elasticity and Hooke's law include the concept of elastic-plastic energy, the concept of Hooke's law, the concept of Young's modulus and the concept of spring potential energy.

One example of students experiencing misconceptions about elasticity and Hooke's law as seen in research conducted by Hidayati (2016) is that students assume that if a material has a greater bending power, it means that the object also has a greater Young's modulus. But actually if a material has a greater flexural strength, it means that the object has a smaller resistance or resistance to stretch when subjected to pressure. Thus, the Young's modulus of the material is also smaller.

**5. 4C Skills**

In the 21st century the government directs Indonesian students to have 4C skills in learning. 4C skills consist of: (1) Critical Thinking Skills, (2) Creative Thinking Skills, (3) Communication Skills, (4) Collaboration Skills. The indicators of 4C skills are as follows:

Table 3. The indicators of 4C skills

| 4C's | Indicator |
|---|---|
| *Critical Thinking Skills* | a. Using inductive reasoning or deductive reasoning<br>b. Analyzing the interrelationships of each part of the whole to produce complex systems<br>c. Analyze and evaluate facts<br>d. Draw conclusions based on the results of the analysis<br>e. Solve unusual/common problems in conventional or innovative ways |
| *Creative Thinking Skills* | a. Creating new ideas<br>b. Expanding basic ideas/concepts to enhance and maximize creative efforts<br>c. Apply creative ideas as a real contribution in |

| | |
|---|---|
| | life |
| *Communication Skills* | a. Expressing thoughts or ideas verbally, in writing or nonverbally<br>b. Use communication for various purposes (e.g. inform, instruct, motivate or invite)<br>c. Using various media or technology in learning |
| *Collaboration Skills* | a. Demonstrated ability to work effectively in groups<br>b. Accept the division of responsibilities and contribute in completing group assignments<br>c. Provide input and show mutual respect for each other |

(Setiyawati ED, et al. 2017)

Critical thinking skills are a directed process in carrying out mental activities such as solving problems, making decisions, analyzing assumptions and conducting scientific research. According to (Elaine B. Johnson, 2009: 182) Critical thinking is the ability to systematically evaluate the weight of one's own opinion and the opinion of others. Facione (2011) states that critical thinking is self-regulation in deciding something so as to produce interpretation, analysis, evaluation, and inference, as well

as exposure of a concept, evidence, methodology, criteria, and contextual considerations that form the basis for making decisions. Through critical thinking skills students are expected to be able to use systems thinking to solve problems, make effective reasons, calculate possibilities, draw conclusions and make decisions (Zubaidah, 2019).

Creative thinking skills are important skills that must be possessed in the 21st century. Creativity is the ability to find new ideas, unique ideas. Creative thinking is synonymous with the ability to find new ideas (Piaw, 2010). Creative thinking can also be defined as the creation of new objects, or improving existing products to make them more attractive (National Education Association, 2010; Partnership for 21st Century Learning, 2015). And creative thinking skills are skills to find new things that have never existed before, are original, develop new solutions for each problem, and involve the ability to generate new, varied, and unique ideas.

Communication aims to send a message to the recipient both orally and in writing so that the recipient can understand what the message is. However, not everyone has good communication skills, some can communicate verbally but cannot in writing, and vice versa. Therefore, in 21st century learning, students are expected to be able to have good communication skills. Communication skills refer to individual skills to communicate clearly, use spoken and written language, verbally and non-verbally and collaborate effectively (Pacific Policy Research Center, 2010).

Collaboration is a skill to develop collective intelligence in terms of helping, suggesting, accepting, and negotiating through interactions with others mediated by

technology (Brown, 2015). Collaborative learning environments challenge students to express and defend their positions and generate their own ideas. By collaborating, students can discuss conveying ideas that exist in students, then students can also exchange points of view with one another, seek clarification, and participate in high-level thinking such as managing, organizing, critically analyzing, solving problems, and create new, deeper learning and understanding (Zubaidah, 2019).

**6. Cognitive Conflict Based Learning Model**

The learning model is the most important element in teaching and learning activities that are used to achieve learning objectives, which are used by teachers when in the learning process. Joyce & Weil (in Rusman, 2012) say the learning model is a plan or pattern used to shape the curriculum, design learning materials, and guide students in class activities. Winataputra (1993) defines the learning model as a conceptual framework for developing learning procedures to achieve learning objectives and serves as a teacher guide in carrying out activities in learning (Suyanto and Jihad, 2013: 134).

Some of the opinions above, it can be concluded that the learning model is a pattern for teachers in designing appropriate and efficient learning in order to achieve the desired learning objectives. The existence of a learning model is a must in the learning process. The development of cognitive conflict-based learning models is carried out based on the consideration that students find it difficult to understand physics concepts and there are many misconceptions in understanding physics concepts. Cognitive conflict learning is very influential in improving understanding

of concepts and reducing students' misconceptions, especially in learning physics (Mufit F, et al. 2020).

The phenomenon of misconceptions cannot be avoided by students because in general, misconceptions occur when students interact with the environment or natural phenomena, and build their own physics concepts based on their intuition. So that when students start the learning process in an educational institution, students already have their own concepts but not necessarily in accordance with scientific concepts. This is where the role of the teacher is to make students aware of their misconceptions, and provide physical phenomena that cause cognitive conflicts, so that in the end students can rebuild scientifically correct concepts.

In implementing problem-based learning, educators need to provide resources that support the development of students' problem-solving skills, which encourage original thinking (such as cognitive conflict) and creativity, generate discussion, and generate reflection. The final stage is the problem analysis stage, the educator plays a role in motivating students in offering answers, hypotheses, and reflections which can consist of closed or open investigations. Closed inquiry has a definite answer, whereas open inquiry can have several answers.

The cognitive conflict-based learning model consists of 4 stages (Mufit & Fauzan, 2019), namely:

i. Activation of Preconceptions and Misconceptions: at this stage the aim is to determine students' prior knowledge before learning begins.

ii. Presentation of Cognitive Conflict: at this stage it is intended that students have conceptual conflicts before they make conceptual changes to determine new ideas scientifically. At this stage, physics is presented that triggers cognitive conflict.

iii. Concept Discovery and Discovery: at this stage the aim is to achieve a long-lasting conceptual understanding in students. In this activity students can conduct an experiment in finding concepts and equations.

iv. Reflection: at this stage the aim is for educators to be able to measure the extent to which the level of understanding of students after making their own concepts and equations discovery. This activity can be done through discussion between students.

**7. Interactive Multimedia**

Teaching materials are materials used to support the learning process used by teachers or instructors in continuing learning (Prastowo, 2011:16). According to Widodo, teaching materials are learning tools that contain learning methods, materials, limitations, and evaluations that are designed in an attractive way to achieve the competencies or sub-competencies of the learning. According to the 2007 Ministry of National Education, teaching materials are divided into several types, namely printed teaching materials, audio teaching materials, audio visual teaching materials and interactive multimedia teaching materials. In the 21st century learning is required to master technology (ICT), it is very suitable to use technology-based teaching materials in the form of interactive multimedia.

Interactive multimedia is included in one type of teaching materials. Interactive multimedia is a combination of images, sounds, animations and videos that are put together in software with the aim of direct interaction between users and software. With the interactive multimedia is expected to increase student interest in learning. Students can also find new ideas or ideas.

According to Sanjaya (2012:226) there are several advantages of using interactive multimedia including:

1. Interactive multimedia is more dynamic so it's not boring
2. Interactive multimedia provides more diverse menu choices so that students as media users have the opportunity to choose their preferred menu
3. A more complete study of subject matter allows interactive multimedia to have more variety of material that students can understand
4. Feedback can be given in a variety of ways so that it can increase student learning motivation.

Interactive multimedia as teaching material must contain at least 7 components, namely, 1) learning instructions, 2) competencies to be achieved, 3) learning materials, 4) supporting information, 5) exercises, 6) worksheets, 7) evaluations, 8 ) response or feedback to the evaluation results (National. 2010). With interactive multimedia, it can trigger students' creativity and curiosity, so that students can experience effective learning. And with interactive multimedia students can be more motivated in learning and easy to understand learning.

## 8. Interactive Multimedia Based on Cognitive Conflict and Integrating 4C Skills

The interactive multimedia created is combined with a cognitive conflict-based learning model that integrates 4C skills. In interactive multimedia used as teaching materials, it must contain a minimum of 7 components, namely: learning instructions, competencies to be achieved, learning materials, supporting information, exercises, worksheets, evaluations and responses or feedback on the evaluation results (National, 2010 ). Teaching materials in general have aspects of knowledge, skills and attitudes (Mufit & Fauzan, 2019). This interactive multimedia teaching material contains a cognitive conflict-based learning model with 4 PbKK model syntaxes, namely: activation of preconceptions and misconceptions, presentation of cognitive conflicts, discovery of concepts and similarities, and reflection (Mufit & Fauzan, 2019). In teaching materials in the form of interactive multimedia, it has 4 phases and it integrates 4C skills with the following explanation.

The first phase, namely activation of preconceptions and misconceptions. This activity is in an interactive multimedia exercise. In this phase, students are given concept questions about elasticity and Hooke's law with the aim of knowing students' understanding of concepts and misconceptions before gaining new knowledge. The 4C skills that are trained at this preconception and misconception activation stage are critical thinking skills.

The second phase, namely the presentation of cognitive conflict. In this phase, questions related to students' daily situations are given that can trigger students'

thinking. Students are asked to write hypotheses and explore ideas for the given phenomenon. The 4C skills that are trained at the stage of presenting this cognitive conflict are creative thinking skills because at this stage students can write down their ideas or thoughts in the provided column.

The third phase, namely the discovery of concepts and equations. In this activity, students can find concepts and equations through direct experimental activities or virtual laboratory experiments provided. The discovery of concepts and equations can be done by students in groups. Students are asked to look for logical relationships, and check the truth of the information that has been found. The 4C skills that are trained at the concept and equation discovery stage are collaborative skills.

The fourth phase is reflection. This activity is an evaluation activity of the components of teaching materials. In this reflection stage, students are asked to re-examine the hypotheses that have been written at the stage of presenting cognitive conflicts and re-read the actual answers. In this phase, students are also given questions in the form of multiple choice questions that can be done, and students can see the scores they have obtained. The evaluation carried out provided information to the teacher on students' understanding of elasticity and Hooke's law. At this stage students can also express the results of the activities that have been carried out previously so that the 4C skills trained at this stage are communication skills.

## 9. Adobe Animate CC 2019

Adobe animate CC is an application program developed for creating animations. Animations can be created with a graphical user interface without having to use programming. Assets from other adobe are also easy to incorporate into this adobe animate CC 2019. Video assets can be imported from Adobe Primary, images can be imported from Adobe Illustrator, and sound can be imported from Adobe Audition. Some of the advantages of adobe animate cc are: being able to choose the template of the electronic product you want to make, being able to create animations, being able to combine it with various links. The product templates provided in adobe animate cc 2019 are android, Apple IOS, Apple TV, Windows, Mac OS desktop (GREEN & Labrecque, 2017).

The provision of various templates makes it easy to build applications without having to use many programming languages for each different type of electronic product. Applications, animations and videos created using adobe animate cc can be launched on computers and smartphones with additional support for adobe AIR menus. This additional menu in the form of adobe AIR provides convenience in producing interesting interactive multimedia in the form of applications that are used on android, IOS, and windows.

Making interactive multimedia using adobe animate CC 2019 can be used as a solution to improve students' understanding of concepts, because in interactive multimedia there is a combination of images and videos that can trigger students'

curiosity. Using software in learning can make learning more effective and interactive (Ramdania, 2013).

This interactive multimedia is found in every syntax in the cognitive conflict-based learning model. At the activation stage of preconceptions and misconceptions, there is feedback in the form of decisions about understanding the concept, misconception, and not understanding the concept after choosing the answers to the problems of elasticity and Hooke's law provided. The interactive content in the cognitive conflict presentation stage is that students can express their thoughts in written form that can be typed in the answer column provided, then the answers that have been written by students can be known whether the answers are in accordance with the concept or not in the available key sections. Interactive at the concept and equation discovery stage, students can do virtual laboratory activities and direct experimental activities to find concepts and equations in the elasticity material and Hooke's law. While interactive contained in the reflection stage, namely students can choose the correct answer from the questions provided, then students can find out how many scores they get from answering the question.

**10. Hooke's Law and Elasticity Materials**

Materials on elasticity and Hooke's law are found in KD 3.2, namely Analyzing the elasticity properties of materials in daily life and KD 4.2, namely Conducting experiments on the elasticity properties of a material along with the

presentation of the results and their physical meaning. This material is taught in class XI SMA in odd semesters.

Elasticity is the property of an object when a force is applied it will change its shape, when the object is removed the force will return to its original shape. Objects that we encounter in everyday life are classified into two properties of objects, namely there are elastic objects and there are plastic objects. An elastic object has stress and strain properties (Hugh D. Young & Roger A. Freedman, 2002). One example of an elastic object that we usually encounter in everyday life is a spring. The spring will exert a force on the load to return it to its equilibrium position. The force on the spring is known as the restoring force. The magnitude of the restoring force F is proportional to the change in the length of the spring x both when the spring is pressed or stretched. There is Hooke's law which states "the tensile or compressive force on a spring is directly proportional to the change in the length of the spring" (Dauglas C. Giancoli, 2001).

In science learning, there are two important things that must exist, namely the process of science and the product of science. The scientific process includes experimental activities, while the product of science is in the form of a body of knowledge. Science products consist of facts, concepts, principles, laws and theories that are systematically arranged (Mufit & Fauzan, 2019).

Fact is a condition, nature or event that has or is happening in a real and true way. Concepts are ideas or ideas obtained from special experiences or events so that

they can be expressed by certain terms or symbols. Principles and laws are causal relationships between two or more concepts derived from some special events. Theory is a building of knowledge consisting of facts, principles, and laws that are interrelated with each other (Mufit & Fauzan, 2019).

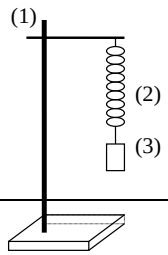
Table 4. The product of science on elasticity material and Hooke's law

| | |
|---|---|
| Fact | • Rubber is an elastic object<br>• Plastic is an inelastic (plastic) object.<br>• Examples of the use of the elasticity of materials in life include slingshots, bows, and Bungee Jumping<br>• The rubber slingshot that is pulled is getting longer and longer.<br>• When a spring is pulled, the length of the spring is increased.<br>• *Spring bed* using a parallel spring arrangement.<br>• In motorcycles and cars, springs are used as a suspension system to reduce sway when moving on uneven roads. Springs on motorcycles and cars are known as shockbreakers |
| Draft | • Elasticity is the ability of an object to return to its original shape when the external force acting on it is removed |

| | |
|---|---|
| | • Elastic objects are objects that if given an external force, the object will experience a change in size or shape, when the external force is removed, the internal force tends to return the shape and size of the object to its original state.<br>• Plastic objects (inelastic) are objects that if given an external force, the object will experience a change in size or shape, when the external force is removed, the object cannot return to its original state.<br>• Plastic objects (inelastic) are objects that if given an external force, the object will experience a change in size or shape, when the external force is removed, the object does not return to its original state.<br>• If the tensile force does not exceed the elastic limit of the spring, the increase in the length of the spring is directly proportional to the tensile force.<br>• The series arrangement aims to reduce the spring constant so that the increase in length experienced by the spring system will be greater.<br>• The parallel arrangement aims to increase the spring constant so that the increase in the length of the |

| | |
|---|---|
| | spring system is smaller than the series arrangement |
| Principle | • Stress (stress) is the magnitude of the force acting per unit cross-sectional area, mathematically it can be formulated:<br>$$\sigma = \frac{F}{A}$$<br>Where: $\sigma$ = voltage (N/m2)<br>$F$ = force (N)<br>$A$ = cross-sectional area (m2)<br>• Strain is the ratio between the increase in length and the initial length, mathematically it can be formulated:<br>$$e = \frac{\Delta L}{Lo}$$<br>Where: $e$ = strain<br>$\Delta L$ = increase in length (m)<br>$Lo$ = original length (m)<br>• The modulus of elasticity is a quantity that describes the level of elasticity of the material, the modulus of elasticity is called Young's modulus. Mathematically, formulated with the equation: |

| | |
|---|---|
| | $E = \frac{\sigma}{e} = \frac{F.Lo}{A\Delta L}$ where E= Elastic Modulus (N/m2 or Pa)<br>• HThe relationship between the magnitude of the force acting with the increase in the length of the spring can be written as follows:<br>$F = -k.\Delta x$<br>Description:F = force acting (N)<br>k = spring constant (N/m)<br>x = increase in spring length (m)<br>• The principle of the series arrangement of several springs is:<br>1) The tensile force experienced by each spring is the same, and this tensile force is the same as the tensile force experienced by the replacement spring<br>2) The increase in the length of the series replacement spring is equal to the total increase in the length of each spring.<br>3) The reciprocal of the series replacement spring |

<table>
<tr>
<td></td>
<td>constant is equal to the total of the reciprocals of each spring constant.<br>$$\frac{1}{k_s} = \frac{1}{k_1} + \frac{1}{k_2} + ... + \frac{1}{k_n}$$<br>• The principle of the parallel arrangement of several springs is:<br>1) The tensile force on the replacement spring F is equal to the total tensile force on each spring<br>2) The increase in length of each spring is the same and this increase in length is equal to the increase in the length of the replacement spring.<br>3) The replacement spring constant in a parallel circuit is equal to the total of each spring constant<br>$$k_p = k_1 + k_2 + ... + k_n$$</td>
</tr>
<tr>
<td>Procedure</td>
<td>1. Prepare the tools and materials that will be used<br>2. Assemble the stand according to Figure 1<br>Information<br>(1) Stative<br>(2) Spring<br> 
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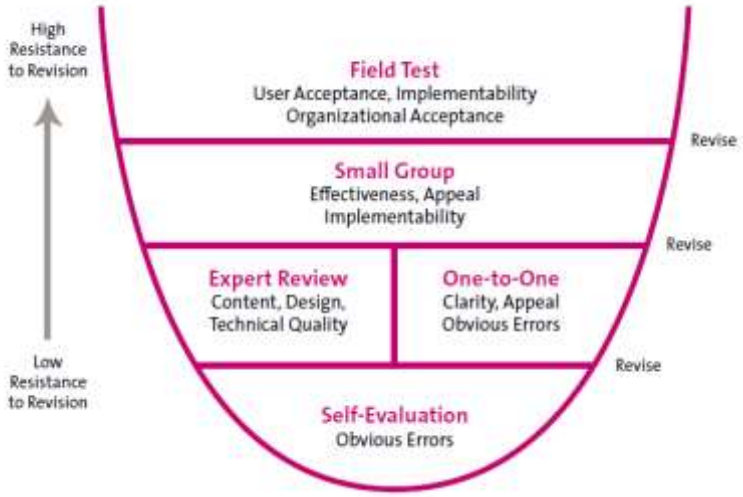
| | |
|---|---|
| | (3) Place to hang the load<br>Figure 1. Schematic arrangement of experimental equipment<br>3. Measure the length of the spring without load (original length of the spring (L0) ), record the results in Table 1.<br>4. Gives a load of mass 50 grams which is hung from the bottom end of the spring.<br><br>Define:<br>1. Measure the length of the spring after being loaded (L1) and record the measurement results in Table 1.<br>2. Repeat step 5 by changing the mass of the load to 100 grams, 150 grams, and 200 grams, and record the measurement results in Table 1.<br>3. Determine the change in length experienced by the spring (ΔL) at each additional load in Table 1<br>4. Compare the weight of the object with the change in length that occurs in the experiment and write the results in Table 1 |

## 11. Plomp Development Model

This research is a development research or also known as design research. This research is a form of research that develops and validates a product so that it is feasible to use. There are 3 stages of research using plomp development including: (1) the preliminary research stage, which is used to determine the initial state or initial condition of a problem. (2) the development stage (development/prototyping research), at this stage there are five steps that must be passed to produce practical interactive multimedia, including: a) designing/designing interactive multimedia based on cognitive conflict, b) self evaluation, c) expert review , d) one to one evaluation, and e) small group evaluation. (3) the assessment phase (assessment phase).

The preliminary research stage is the stage that analyzes research needs, by conducting a literature review. The purpose of the preliminary research stage is to determine the initial conditions for a problem to be studied. The development stage (development/prototyping research) is the development stage which consists of 5 steps, at this stage a product is made and then an assessment is carried out to measure the level of product validity, practicality and product effectiveness level with the aim of perfecting the product to be developed. The assessment phase is used to conclude whether the product that has been made meets predetermined specifications. This stage often produces suggestions for product improvement or what is commonly called the semi-summative stage (Plomp T & Nieveen N, 2013).

The evaluation stage of development research using the plomp model can be seen in the following tessmer diagram:




Picture 1. Formative Evaluation (Tessmer, 1993, in Plomp 2013)

Based on the tessmer diagram above, what is done after the design stage is completed, the next thing to do is:

1. Self-Evaluation, at this stage the product that has been designed and made by the researcher is then carried out by the researcher himself in order to improve the product before it is given to the validator later. If there are still things that can be said to be not appropriate by the researchers themselves, then revisions are made first. However, if the researcher's assessment of the product made is good and good, it can be continued at the next stage, namely Expert Review.

2. Expert Review, which is the stage carried out for product assessment. In this expert review, it is submitted to 3 validators. The validator assesses the validity of the content, the validity of the presentation, the feasibility of the language and the feasibility of the graphics of the interactive multimedia or product that has been made. If the validator states it can be used but needs to be revised then the product is revised first until the validator states the product can be used. Then proceed to the next stage, namely the one-to-one stage.
3. One-to-one evaluation, namely the product trial stage to 3 students with high, medium and low abilities. At this stage the level of practicality is measured according to the 3 students. If according to the 3 students, the product being tested is practical, then it can be continued at the next stage, namely the small group stage.
4. Small Group, namely the product trial stage which is carried out on 9 students with high, medium and low abilities. At this stage the practicality and effectiveness of the product is tested. If the product used is effective, the next stage can be carried out, namely the field test stage.
5. Field Test, which is the product test stage for all students who are studying the material being tested, at this stage it is carried out when conditions are normal in order to see whether all students can really improve their understanding of the concept using the multimedia or not.

However, in the current state of the Covid-19 pandemic, the research conducted is limited to the small group stage, which means research is only up to low-level research.

**12. Product quality**

The product developed will be determined for its validity and practicality. Determination of validity and practicality using the analysis of the validity and practicality sheet with the following details:

a. Validity Analysis

Van den Akker (1999:10) states that validity refers to the level of intervention design that is based on state-of-the-art knowledge and the various components of the intervention that are related to each other. Validity means the accuracy and accuracy of a measuring instrument in carrying out its measuring function. The validity of interactive multimedia was carried out by 3 physics lecturers at the Faculty of Mathematics and Natural Sciences, UNP, by filling out the validity sheet that had been made, the indicators being obtained from the Ministry of National Education on IT-based teaching materials. With the following indicators:

Table 5. Validity Indicator

| No | Rated aspect | Scope of assessment |
|---|---|---|
| 1 | Material Substance | 1) In accordance with scientific principles<br>2) Material equipment<br>3) Contemporary (actualization in terms of material)<br>4) Legibility |

| | | |
|---|---|---|
| 2 | Visual communication display | 1) Navigation<br>2) Letter<br>3) Media (files, sounds, images, and animations)<br>4) Color<br>5) Animation<br>6) Layout |
| 3 | Learning Design | 1) Title clarity<br>2) Clarity of SK-KD<br>3) Clarity of learning objectives<br>4) Material clarity<br>5) Problems example<br>6) Practice/Test/Simulation<br>7) Compilation<br>8) Reference |
| 4 | Software utilization | 1) Use of fonts, types and sizes<br>2) Interactivity (feedback from user system)<br>3) Support software<br>4) Originality |

(Kementrian Pendidikan Nasional, 2010)

Based on Table 5 a product is said to be valid if it meets all aspects of the assessment well so that it can be used in learning.

b. Practical analysis

The practicality of a product is tested on students, then students give an assessment of the products used. Students fill out practical sheets according to predetermined indicators. The assessment aspects contained in the practicality sheet can be seen in the following table:

Table 6. Practical aspects according to experts

| The experts | Practical Component |
|---|---|
| Sukardi (2012) | 1) Make it easier for teachers to use the product<br>2) Product recall<br>3) Easy to use anytime |

| | |
|---|---|
| KBBI | 1) Easy to use<br>2) Easy to use<br>3) Efficiency (labor, cost, time) |
| Zainal Arifin (2009) | 1) Easy to use by teachers or others<br>2) Clear product<br>3) Time provided to expedite evaluation |
| Van den Akker (1999) | 1) Users consider it can/easy to use |

Based on Table 6 above, practicality contains responses or assessments from students. The practicality instrument contains the attractiveness of interactive multimedia, its convenience, efficiency in learning and usefulness in learning.

**B. Relevant Research**

Research that is relevant to this research is research conducted by:

1. Hanum Siti Asma, Muft F and Asrizal (2019) with the title Pengembangan LKS Berbasis Konflik Kognitif Terintegrasi Literasi Baru Pada Materi Fluida Untuk Siswa Kelas XI SMA. The results of this development research are to produce practical cognitive conflict-based worksheets so that they can improve students' conceptual understanding of the material. The similarity of this research with the research that will be carried out by the researcher is the manufacture of products in the form of teaching materials using a learning model that is both based on cognitive conflict. The difference between this research and the research that will be conducted is the type of teaching materials that will be produced. This research produces worksheets while the

research that will be carried out by researchers will produce teaching materials with interactive multimedia types.

2. Annisa Fadhilah, Fatni Mufit, Asrizal (2020) with the title Analisis Validitas Dan Praktikalitas Lembar Kerja Siswa Berbasis Konflik Kognitif Pada Materi Gerak Parabola. The result of this research is to produce a valid and practical work sheet based on cognitive conflict that will be used by students. The similarity of this research with the research that the researcher will do is that they both use a cognitive conflict-based learning model in the manufacture of teaching materials. While the difference between this research and the research that the researcher will do lies in the type of teaching materials, this study uses student worksheets while the research that the researchers will do uses interactive multimedia-based teaching materials.
3. Nyoman P Suwindra, et al (2012) with the title of Pengembangan Modul Software Multimedia Interaktif Dengan Strategi Pembelajaran Berbasis Masalah Untuk Meningkatkan Pemahaman Konsep Dan Hasil Belajar Fisika Siswa Kelas XII SMA. The purpose of this research is to produce an interactive multimedia physics module that has been tested for its feasibility for learning facilities for class XII high school students. The specific target to be achieved is to test the comparative advantage between the developed modules and learning strategies on the acquisition of understanding and student learning outcomes. The similarity of the research conducted by the researcher with this study is that they both use interactive multimedia to

improve students' conceptual understanding, but the difference is that in this study the strategy used is problem-based, while the research that the researcher will do uses a cognitive conflict-based learning model.

4. Inung Diah Kurniawati, et al (2018) with the title of Media Pembelajaran Berbasis Multimedia Interaktif Untuk Meningkatkan Pemahaman Konsep Mahasiswa. The purpose of this study is to provide learning innovations in physics courses so that students have high motivation for physics subjects. This of course can be applied to high school students. The similarity of the research conducted by the researcher with this study is that they both use interactive multimedia to improve students' conceptual understanding, but the difference is that this study does not use cognitive conflict-based learning while the research that will be conducted by researchers uses a cognitive conflict-based learning model.

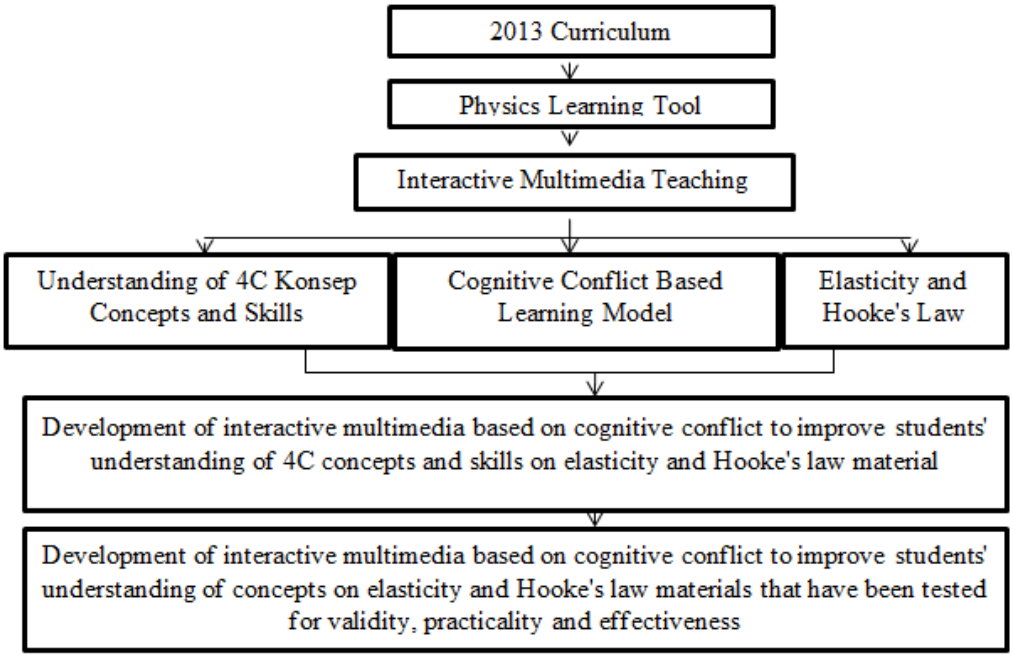
**C. Framework of thinking**

The learning process used today uses the lecture method. In today's learning, there are still a lot of literacy that is used that is still human-based, namely the teacher. Not many schools use technology-based literacy. With this lecture method, it has not stimulated students to think critically and find information on their own. With the lecture method and human-based literacy, there are often misconceptions experienced by students. To improve students' misconceptions, it can be done with cognitive conflict-based learning and using technological literacy in the form of interactive multimedia-based teaching materials. Because in interactive multimedia

there is a combination of images, videos, sounds and animations that can make direct interaction with students, so that there is a deeper interest and curiosity of students towards the material of elasticity and Hooke's law. The steps for learning cognitive conflict according to (Mufit, 2018) are: 1) activation of preconceptions and misconceptions, 2) presentation of cognitive conflicts, 3) discovery of concepts and similarities, 4) reflection.

Interactive multimedia-based teaching materials with cognitive conflict learning models for physics lessons, especially on elasticity and Hooke's law are intended to make it easier for students to understand concepts and stimulate student activity in learning. This learning media is made so that students are more happy and interested in learning physics.

The framework of thinking in this research is presented in the following flowchart:




Picture 2. Framework of thinking

By using interactive multimedia with this cognitive conflict-based learning model, students are required to be able to improve their ability to utilize technology and are required to be more active, creative, and innovative so that they can train students' memory and understanding of concepts so that there are no misconceptions. After doing learning with interactive multimedia, it is expected that students can have a good understanding of the concept and there will be no misconceptions.

# CHAPTER V
# CLOSING

## A. Conclusion

Based on the research and discussion that has been stated, the following conclusions can be drawn.

1. Cognitive conflict-based interactive multimedia has characteristics that contain 4 syntaxes of cognitive conflict-based learning models, including; activation of preconceptions and misconceptions, presentation of cognitive conflicts, discovery of concepts and similarities and reflection. The third stage is the discovery of concepts and equations that integrate the virtual laboratory. Interactive multimedia consists of title components, competency standards and basic competencies, indicators of competency achievement, materials, practice questions, competency tests and references. Interactive multimedia in the form of android applications that can be used on smartphones when in direct or indirect learning (online).

2. The results of interactive multimedia validation based on cognitive conflict obtained from experts are categorized as valid. The characteristics of product validity are material substance, learning design, visual communication display and software utilization.

3. The practical results of interactive multimedia based on cognitive conflict which were carried out at the one to one evaluation stage and the small

group stage obtained from students were categorized as very practical. The practical characteristics of the product are ease of use, attractiveness, efficiency, and benefits in the learning process.

4. The use of interactive multimedia based on cognitive conflict can improve students' understanding of 4C concepts and skills on elasticity and Hooke's law.

**B. Suggestion**

1. Teachers can use interactive multimedia based on cognitive conflict to improve students' understanding of 4C concepts and skills, especially on elasticity and Hooke's law and can be used during online and offline learning (blanded learning).
2. Students can use interactive multimedia based on cognitive conflict to improve their understanding of 4C concepts and skills on elasticity and Hooke's law.
3. Other researchers can develop cognitive conflict-based interactive multimedia for two semesters.

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