Validity and practicality of interactive multimedia based on cognitive conflict integrated new literacy on thermodynamic and mechanical waves material for class xi high school students

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Abstract. The reality in the school shows that literacy students have not been implemented well and still have a low understanding of physics concepts as well as misconceptions of physics by students. The unavailability of teaching materials or multimedia that can specifically improve literacy and student's understanding of concepts. The goal of this research is to develop interactive multimedia based on cognitive conflicts integrated with new literacies that are valid and practical. The research was conducted using a type of research of Plomp model development. The object of research is the interactive multimedia cognitive conflict. Product validity was tested using the instrument validity by the experts consisting of 5 lecturers of Physics, test the practicality of the product using the instrument practicality are one to one and small group by the students of class XI of SMAN 2 Padang. Data analysis techniques for validity and practicality of the product used descriptive statistical analysis. Interactive multimedia based on cognitive conflicts integrated new literacy on thermodynamics and wave mechanics materials for students of class XI high school is valid and practical. Interactive Multimedia can be used by teachers and students in learning activities.

1. Introduction
In the current era, the development of the 4.0 industrial revolution era is term is known as the internet of things (IoT). The industrial revolution era began to touch the virtual world, shaped the connectivity of humans, machines and data, all existing everywhere. To realize the goals of national education, the education system requires various innovations so that it can adapt to the era of industrial revolution 4.0 which is developing very rapidly. The development of technology in the era of industrial revolution 4.0 requires students to be able to master 21st-century skills or the term 4C (Communication, Collaboration, Critical Thinking and Problem Solving, and Creativity and Innovation) which are real abilities that are targeted by the 2013 Curriculum. Students require skills to learn to get success in learning such as critical thinking, creative thinking and collaboration, communication [1].
The government has made improvements to the curriculum from the School-Based Curriculum (SBC) to the 2013 curriculum. After the 2013 curriculum was implemented, the government evaluated the curriculum which was considered to be still lacking in the 2013 curriculum so that the curriculum was refined into the 2017 revised curriculum. The refinement of the curriculum 2013 to be curriculum revised 2017 aims to prepare the nation's children Indonesia to compete with other nations in the progress of the 21st century very rapidly, as well as demanding the mastery of skills soft skills on implementation daily and critical thinking skills, logical, relative, meta-cognitive, and critical thinking which is the ability to think high.

It can be said the curriculum has to support the optimal learning of physics. Physics is learning to learn the knowledge that can develop analysis and reasoning power. So that almost all problems related to natural Science can be understood. To be able to understand physics extensively, then it should start with the ability to understand basic concepts that are there in physics lessons. The success or failure of the learners in understanding the learning of physics is determined by the understanding of physics. Nature that occurs in the field shows that problems such as lack of understanding of the concept and literacy in students [2]. This can be seen based on the initial study by conducting interviews with teachers and giving conceptual understanding questions to students which were carried out three of the schools.

First, the results of interviews with 3 teachers were conducted to determine the implementation of the learning model of Physics, the teaching materials used and literacy is applied. Currently, the ranking of literacy of the scientific Indonesia students is still low and inferior to other countries [3]. Second, giving questions to students to find out students' understanding of the physics concepts that have been learned to increase new literacy. The results obtained from the interview were teaching materials used in the form of worksheets that had not applied a certain model and students' literacy was still limited, namely old literacy (reading, writing, and arithmetic). Meanwhile, students' understanding of the concept of physics and the application of new literacy is still low.

The results of the preliminary study show the low implementation of the learning model according to the 2017 revised 2013 Curriculum, the minimal use of other teaching materials such as book teaching materials, and the low application of new literacy. The solution to overcome the problems found in the field is to make teaching materials in the form of cognitive-based interactive multimedia based on the syntax of cognitive conflict based learning models. There are 4 syntaxes of cognitive conflict based learning models, namely (1) activation of preconceptions and misconceptions, (2) presentation of cognitive conflict, (3) discovery of concepts and equations, and (4) reflection [4,5]. With the existence of Interactive Multimedia, it is hoped that it can increase the new literacy of students and make it easier for teachers to present material to students. The use of interactive multimedia in learning is also very supportive to improve the expected thinking skills [6].

The cognitive conflict based learning model can be interpreted as one way to overcome any perceptions of a person between the initial knowledge obtained from the environment by the science of scientific fact [7]. Cognitive conflict models are very important for change in the conceptual learning of students. Cognitive conflict based learning model can be used to improve the conceptual understanding and reduce misconceptions of students. The purpose of this study was to determine the validity and practicality of interactive multimedia based on cognitive conflict integrated literacy on thermodynamic material and mechanical waves for class XI high school students.

2. Material and Method
This research uses the type of Development Research. The development model in this research uses the Plomp model (2013) [8]. The product that will be produced from this research is interactive multimedia based on cognitive conflict integrated with new literacy on thermodynamics and mechanical wave material for class XI high school students. The object of this research is the learning device that is Multimedia-based Interactive cognitive conflict. Interactive Multimedia is composed of two basic competencies (BC), BC 3.7 Analyze the change of state of an ideal gas by applying the laws of Thermodynamics and BC 3.8 Analyze the characteristics of mechanics wave.
Interactive multimedia based on cognitive conflicts to improve students' new literacy is designed first and then validated by experts, responded to by students, and tested in schools. Cognitive conflict-based development research consists of three stages, namely: (1) preliminary research, (2) development or prototyping phase, and (3) assessment phase [8]. This study only reports the section: prototyping phase.

The Prototyping Phase consists of prototype design and formative evaluation, and prototype revision. In this period, it aims to design a temporary prototype, evaluate the prototype, and revise it into a fixed product. Meanwhile, formative evaluation and prototype revision was carried out to test the validity and practicality of the prototype. Activities at this stage began with self-evaluation by the researcher himself. Furthermore, the prototype is validated through a team of experts (expert review). The product that was declared valid by the expert team was then carried out by a prototype practicality test through two stages, namely one to one and small group evaluation by students at SMAN 2 Padang.

The data collection instruments for the preliminary stage were concept tests and interview guides. At the development stage using a validity questionnaire sheet instrument, a student practicality questionnaire instrument. The validity of Multimedia is seen from the questionnaires filled out by experts. The statistical test carried out is descriptive analysis, which is described through graphs and tables. Weighting is done based on the Likert scale. The value of the weights calculated by dividing the score obtained to the maximum score multiplied by 100. The range of score values valid between 0-100 that can be seen in the table below.

| No | Percentage (%) | Category    |
|----|----------------|-------------|
| 1  | 0-20           | Very Weak   |
| 2  | 21-40          | Weak        |
| 3  | 41-60          | Enough      |
| 4  | 61-80          | Strong      |
| 5  | 81-100         | Very Strong |

The practicality of interactive Multimedia is seen from the results sheet students 'responses stage one to one and students' stage of small group grade XI senior high School form of a questionnaire. The value of the weights calculated by dividing the score obtained to the maximum score multiplied by 100. The range of score values practicality between 0-100 that can be seen in the table below.

| No | Percentage (%) | Category    |
|----|----------------|-------------|
| 1  | 0-20           | Very Weak   |
| 2  | 21-40          | Weak        |
| 3  | 41-60          | Enough      |
| 4  | 61-80          | Strong      |
| 5  | 81-100         | Very Strong |

3. Results and Discussion

3.1. Result
In prototype phase, interactive multimedia is designed using the Macromedia Flash 8 application. Macromedia Flash 8 is a product/software that is used to create and process animation, images or multimedia using vectors for a small scale. Files generated from this software use a flash extension (.swf) and can be run via a browser/web. Interactive multimedia
with action functions that are useful in offering commands to carry out interactive functions on multimedia. In general, misconceptions occur because of the previous knowledge acquired by the students when interacting with nature before they enter school [10].

The results of the Design phase of the Prototype carried out a self-evaluation against the product of the researcher’s own before validated by experts. At this stage, researchers correct the typing errors and concepts in the manufacture of multimedia and adding parts that are considered less. On Physics interactive multimedia, the structure of the interactive multimedia is by the ministry of Education 2010 i.e. the title, competency standards and learning competency, supporting information, the material in the learning, practice, and assessment. Preparation of interactive multimedia conforms with the syntax-based learning cognitive conflict activation preconception and misconceptions, the presentation of conflict-cognitive, the discovery of concepts and equations as well as reflection [11]. Interactive Multimedia is already loading the new literacies.

Furthermore, validated by experts, the results of interactive multimedia validity based on cognitive conflict were obtained from the validity sheet instrument filled in by 5 Physics lecturers of FMIPA UNP by using the validity sheets. In the validity assessment instrument, there are 5 components, namely the validity of material substance, design, appearance, software utilization, and language. As for the components of the validity assessment instrument, there are several indicators.

First, on the components of the assessment validity the substance of the material consists of 3 indicators, that is 1) interactive multimedia made not to deviate from the truth of science, 2) interactive multimedia presented by the depth of knowledge, 3) interactive multimedia presented under the development of science. Results plot the value of the indicator component validity and the substance of the material can be seen in figure 1.

Based on figure 1 can be explained scores on each indicator of the component validity of the substance of the material ranges between 80 to 85 Of the three indicators, there are two categories of validity, which are very strong and strong. In the category of very strong with a value of 85 and which are in the strong category with a value of 80. The average value obtained on the components of the validity of the substance of the material is 81.33. Thus the components of the validity of the substance of the material on the level of validity are strong.

Second, component design validity using nine indicators. The results of the analysis of each of the indicator components of the design shown in Table 3.
Table 3. The results of the analysis of the components of the design

| No | Aspects                                           | Value | Level of Validity |
|----|---------------------------------------------------|-------|-------------------|
| 1  | The suitability of the Title with the Material    | 95    | Very Strong       |
| 2  | Includes CC and BC                                | 100   | Very Strong       |
| 3  | Include Competency Indicators                     | 90    | Very Strong       |
| 4  | Include Learning Objectives                       | 90    | Very Strong       |
| 5  | Material in accordance with the indicators        | 80    | Strong            |
| 6  | Exercises accordance with the indicators          | 80    | Strong            |
| 7  | Include The Identity Of The Authors               | 100   | Very Strong       |
| 8  | Steps CBBL Model Observed Clearly                 | 85    | Very Strong       |
| 9  | Steps CBBL Model lead students to understand the concept | 85 | Very Strong |

Average 89.44 Very Strong

Based on Table 3 it can be described as the value on each of the indicators of the components of the design validity, which ranged from 80 up to 100. Of the nine indicators in the component of design validity in a Multimedia Interactive Physics, there are two categories of validity, that is very strong and strong. In the category of very strong ranges between the value to 85 to 100 and the strong value of 80 of the average value obtained on a component of design validity is 89.44. Thus the components of the design validity at the level of validity are very strong.

Third, the components of the validity display using eight indicators. The results of the data analysis the value of each indicator of the display components shown in Table 4.

Table 4. The results of the analysis of display components

| No | Aspects                                           | Value | Level of Validity |
|----|---------------------------------------------------|-------|-------------------|
| 1  | Basic Navigation                                  | 95    | Very Strong       |
| 2  | Letters and Frames that are Proportional          | 80    | Strong            |
| 3  | The Appearance of the Interactive Multimedia is Simple, Clear and Legible | 80 | Strong |
| 4  | Conformity Between the Picture and the Video with the Material | 80 | Strong |
| 5  | The Composition Of Attractive Colors              | 80    | Strong            |
| 6  | Animated Videos in Accordance with Material       | 75    | Strong            |
| 7  | Interactive Multimedia Display in Accordance with Material | 75 | Strong |
| 8  | Layout Design Interactive Multimedia Proportional  | 85    | Very Strong       |

Average 81.25 Very Strong

Based on Table 4, it can be explained that the value on each indicator of the design validity component ranges from 75 to 95. Of the eight indicators in the display validity component of the Physics Interactive Multimedia, there are two validity categories, that is very strong and strong. In the very strong category ranges between 85 to 95, the strong category ranges between 75 and 80. The average value obtained in the design validity component is 81.25. Thus the design validity component is at a strong level of validity.

Fourth, the component of software utilization validity uses two indicators. The two indicators on the chart are located on a horizontal axis. These indicators include 1) There is feedback from the system to
users on interactive multimedia, 2) Interactive multimedia has the authenticity of the work. The results of the value data plot for each indicator of software utilization are shown in Figure 2.

![Software Utilization Validation](image)

**Figure 2.** The value of software utilization validity components

Based on Figure 2, it can be explained that the value of each indicator of software utilization validity ranges between 80 up to 95. Of the two indicators, the validity component of software utilization in interactive multimedia based on cognitive conflict, there are two categories of validity, that is very strong and strong. The average value obtained in the validity component of software utilization is 87.5. Thus the graphic component is at a strong level of validity.

Fifth, the language validity component uses seven indicators. The results of analyzing the value data of each indicator for the language component are shown in Table 5.

| No | Aspects                                                                 | Value | Level of Validity |
|----|------------------------------------------------------------------------|-------|-------------------|
| 1  | According to Students’ Thinking Level                                  | 80    | Strong            |
| 2  | Has A Value Of Politeness                                              | 90    | Very Strong       |
| 3  | Communicative and Informative                                          | 85    | Very Strong       |
| 4  | Language Does not Mean Multiple                                        | 90    | Very Strong       |
| 5  | The Term Used Has Been Agreed                                          | 85    | Very Strong       |
| 6  | Spelling Used Refers to Enhanced Indonesian Spelling System            | 75    | Strong            |
| 7  | The Rules of Grammar of Indonesian is Good and Right                   | 80    | Strong            |
|    | **Average**                                                            | **83.57** | **Very Strong** **Table 5.** Results of language component analysis

Based on Table 5 can be explained scores on each indicator of the components of the validity language the range between 75 up to 90. Of the seven indicators on the components of the validity language on the Interactive Multimedia Physics, there are two categories of validity, that is very strong and strong. In the category of very strong ranges between the value to 85 to 90 and which is in the category of strong ranges between the value to 75 to 80. The average value obtained on a component of design validity is 83.57. Thus the components of the design validity at the level of validity are strong.

The average value of each validity component in Interactive Multimedia Based on Cognitive Conflict in Thermodynamics and Mechanical Wave to Improve New Literacy for Class XI SMA can be determined from the average value of the five interactive multimedia validity components. In this interactive multimedia, five components have been analyzed. The five components include, 1) the validity of the substance of the material, 2) design validity, 3) validity of the display, 4) validity of the
utilization of the software and 5) validity of the language. The results of the interactive multimedia validity value plot for each validity component are shown in Table 6.

Table 6. The results of the Analysis Validity interactive Multimedia

| No | Aspects                                      | Value | Level of Validity |
|----|----------------------------------------------|-------|-------------------|
| 1  | The Validity of The Substance of The Material | 81.67 | Very Strong       |
| 2  | Design Validity                              | 89.44 | Very Strong       |
| 3  | Validity of The Display                      | 81.25 | Very Strong       |
| 4  | Validity of The Utilization of The Software   | 87.5  | Very Strong       |
| 5  | Validity of The language                     | 83.57 | Very Strong       |
|    | Average                                      | 84.69 | Very Strong       |

Based on Table 6, the average value for each component of the validity assessment in interactive multimedia varies, ranging from 81.25 to 89.44 with an average value of all components of 84.69. From this value, it can be concluded that overall interactive multimedia components are in the very strong validity category. Thus, Interactive Multimedia Based on Cognitive Conflict in Thermodynamics and Mechanical Waves to Improve New Literacy has a very strong level of validity.

The results of the Interactive Multimedia validity obtained suggestions from experts to be revised again. Suggestions are given in the form of a display design of Interactive Multimedia, including the application of cognitive conflicts and new literacy, depth of material, and questions contained in Interactive Multimedia. Advice from experts is used to improve the feasibility of the Interactive Multimedia that is made.

Practicality test results according to students at the one to one stage, and small groups. First, the practicality test according to the one-to-one stage students was carried out at SMAN 2 Padang to three students who had strong, medium, and low ability levels. The practicality test results were obtained from the analysis of the practicality test sheet according to the students. The practicality test instrument that was filled in by the students was a questionnaire on the use of interactive multimedia based on cognitive conflicts. On the practicality test sheet instrument according to the one to one stage students consisted of four components. These components include: 1) ease of use, 2) attractiveness, 3) efficiency, and 4) benefits. The average value of interactive multimedia for each component of practicality assessment according to students can be seen in Figure 3.

![Figure 3. Results of practicality (one to one) interactive multimedia components according to students](image-url)
Based on Figure 3, it can be seen that the average value of each component in interactive multimedia is based on cognitive conflict. The value of the ease of use component was 86.9, the attractiveness component value was 87.5, the efficiency component value was 83.33, and the benefit component value was 94.42. Based on these values it can be argued that all components of interactive multimedia are in the category of very strong. The average value obtained for the practicality assessment component is 88.04.

Second, interactive multimedia practicality tests according to students at the small group stage were carried out at SMAN 2 Padang to 9 students who were divided into 3 small groups. The practicality test results were obtained from the analysis of the practicality test sheet according to the students. The practicality test instrument that was filled in by the students was a questionnaire on the use of interactive multimedia based on cognitive conflicts. In the instrument, the practicality test sheet according to students consists of four components. These components include: 1) ease of use, 2) attractiveness, 3) efficiency, and 4) benefits. The average value of interactive multimedia for each component of practicality assessment according to students can be seen in Figure 4.

![Figure 4. Results of Interactive Multimedia Practicality (small group) according to students](image)

Based on Figure 4, it can be seen that the average value of each component in interactive multimedia is based on cognitive conflict. The value of the ease of use component is 94.84, the attractiveness component value is 95.14, the efficiency component value is 97.22, and the benefit component value is 96.3. Based on this value, it can be argued that the interactive multimedia component is in a very strong category. The average value obtained for the practicality assessment component was 95.87. Practicality refers to the extent to which the attractiveness and ease of use of teaching materials in normal conditions during the learning process for teachers and students [12]. Thus, interactive multimedia based on the cognitive conflict on thermodynamic material and mechanical waves to improve the new literacy of class XI SMA students has a very strong level of practicality.

3.2. Discussion

Based on the results of data processing, the validity of interactive multimedia has a validity value with very strong criteria. The validity characteristics of this product are valid in terms of material substance validation, design validation, appearance validation, software utilization validation and language validation. This is due to several factors that support this, among others: First, interactive multimedia has been prepared by interactive multimedia components according to the Ministry of Education and Culture 2010, namely titles, instructions, learning, competency standards, and competencies to be achieved, supporting information, learning materials, practice questions, and assessments. Second, the learning model in interactive multimedia according to the syntax proposed by Mufit and Ahmad...
Fauzan (2019), namely: 1) activation of preconceptions and misconceptions, 2) presentation of cognitive conflict, 3) discovery and equation concepts, and 4) reflection [4]. Based on the validity results, the developed interactive multimedia facilities can be used and the following needs. This is in line with Hanum's (2019) study of valid cognitive conflict-based worksheets in remediating misconceptions [13].

Interactive multimedia is valid in terms of material substance validation, design validation, display validation, software utilization validation, and language validation. From the results of the interactive multimedia validation, besides being used to determine the feasibility of interactive multimedia, it is also a guide in making revisions to interactive multimedia products that have been made. Interactive multimedia that has been valid has the potential to reduce misconceptions and new literate because interactive multimedia has used a cognitive conflict-based learning model. This is the following research by Mufit (2018) on the impact of cognitive conflict-based learning models to improve students' conceptual understanding [5].

Interactive multimedia has been practical in terms of the components of ease of use, attractiveness, efficiency, and benefits. From the practicality of interactive multimedia, it is also used to determine the feasibility of interactive multimedia as well as a guide in making revisions to interactive multimedia products that have been made. Cognitive conflict-based interactive multimedia is easy to use because interactive multimedia has instructions in terms of use, can be used at any time and there is feedback in its use. This follows Annisa Fadhilah's (2020) research on cognitive conflict-based worksheets that allows students to learn material independently [14].

4. Conclusion
Based on the results of the research and discussion that has been done, conclusions can be made. The results of interactive multimedia validity based on the cognitive conflict on thermodynamic material and mechanical waves have a very strong validity value. The practicality results of interactive multimedia based on cognitive conflicts on thermodynamic material and mechanical waves have a very strong practical value. It can be concluded that Interactive Multimedia based on Cognitive Conflict on Thermodynamics and Mechanical Waves is practical in learning to improve students' new literacy skills.

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