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DESIGN VALIDATION OF REVISED BLOOM TAXONOMY ORIENTED LEARNING DEVICES ON ELASTICITY MATERIALS FOR PHYSICS LEARNING IN HIGH SCHOOL

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ABSTRACT

The development of science and technology in the 21st century is marked by the use of brain work, which is more important than muscle work which has been replaced by intelligent robots. Therefore, efforts to increase the quantity and quality of knowledge through thinking and reasoning exercises are very important to be applied in education. However, after 8 years of implementing K-13, the conditions in the field documents for teacher learning tools show that they still do not meet these expectations. This study aims to develop high school physics learning tools oriented to the revised Bloom's taxonomy on elasticity material. This research is included in Research and Development (RnD) by applying ADDIE. The stages carried out only reached the development stage (validation) which involved 3 lecturers from the Department of Physics FMIPA UNP and 3 physics teachers in Kuantan Singingi Regency as a team of experts and a team of practitioners. The results showed that the feasibility of the resulting product design for lesson plans obtained an average validation value of 82.37% (very valid), and an average validation value of 80.39% (valid). For teaching materials, the average result of lecturer validation is 86.49% (very valid), and the average value of teacher validation is 87.87% (very valid). For the evaluation instrument, the average value of lecturer validation is 79.48% (valid), and the average value of teacher validation is 76.24 % (valid). In general, this study concludes that the resulting learning device designs are in the category between valid and very valid.

Keywords : *Teaching materials; the dimensions of knowledge; cognitive processes; elasticity and Hooke law*

I. INTRODUCTION

The growth of science and technology in the 21st century has changed the order in various aspects of human life. The change that we can feel is in the form of technological sophistication that has taken over most of the work of human muscles with machines and smart robots. This condition must be addressed by increasing the quality and quantity of knowledge needed and maximizing the functioning of the brain by thinking and reasoning. With the complexity of the knowledge possessed, the ability to think intelligently, and the ability to adapt each person to live in various situations, all life cases can be handled properly [1]. Therefore, efforts to increase the quantity and quality of knowledge through thinking and reasoning exercises are very meaningful to be applied in the learning bench through the implementation of the 2013 curriculum. The taxonomic thinking competence arrangement is divided into 6 levels ranging from the lowest to the complex, covering the abilities: remembering, mastering, practicing, analyzing, evaluating, and creating [2]. On the other hand, the scope of knowledge is divided into 4, namely: factual knowledge, conceptual knowledge, procedural knowledge, and metacognitive knowledge [3]. Armed with various dimensions of knowledge and various levels of trained thinking processes, as well as the 4C skills that students must have in the learning process, it is hoped that educators can prepare a skilled and tough golden generation [4].

Implementation of the 2013 curriculum in operations that is tried by subject teachers is through the preparation of educational planning, implementation, and assessment. Educational planning can be seen from the

quality of the lesson plans, teaching materials, and media as well as the resources used by the teacher. The implementation of education can be seen from the quality of the 5M component in the scientific approach mandated by the curriculum and the selection of an education model that is student-centered and has contextual character (linking it to everyday life) [3]. On the other hand, educational assessment can be seen from the assessment designed by the teacher to evaluate the achievement of students. We recommend that an educational process that is prepared and tested by the teacher, it can increase the quantity and quality of students' knowledge which increases in the skills and personality characteristics of students [5].

Taxonomy comes from Greek which consists of 2 words, namely taxis which means arrangement or division, and nomos which means law. So that etymological taxonomy means a law that controls something. Taxonomy can also be referred to as a grouping of things originating at a certain level. The changes that occurred based on the considerations of David Krathwohl and Anderson in 2001 are: first, knowledge can be seen from two aspects, namely from the material aspect and the work aspect. For this reason, the dimensions of knowledge are formed which are separate dimensions and belong to a series of levels of cognitive processes. Second, comprehensive, application, and analysis which means understanding, use, or application and analysis is changed to a verb to understand, apply or use and analyze. Third, synthesis means a combination or combination replaced by creating which means creating or making, which is the highest level of cognitive processes. Fourth, evaluation means that assessment is changed to evaluate which means assessing, its position is before creating.

Learning tools are all forms of components that support the implementation of learning that are used by teachers in the classroom so that learning materials are conveyed properly to students. Learning tools needed by teachers in the teaching and learning process can be in the form of syllabus, Learning Implementation Plans, Worksheets, assessments or Learning Outcomes Tests, and learning media [6]. The learning tools designed in this research are lesson plans, teaching materials, and evaluation instruments. The lesson plan consists of components such as: starting from school identity, subjects, competencies, and indicators that must be achieved, subject matter to learning steps, and assessment [6]. In the lesson plan, there is a formulation of competency achievement indicators which are compiled using Operational Verbs according to the level of cognitive processes and the scope of the knowledge dimensions. Furthermore, learning objectives can be developed based on indicators by considering the principle of ABCD+K, where K is (Knowledge) [7]. Some of the functions of teaching materials include: as a guide for teachers to direct student activities, as a reference for students to study learning materials, and as an assessment tool. Teaching materials should contain the dimensions of knowledge that can be described in the essential material in the subject matter. So that learning is formed with complete content. Evaluation instruments or what are often referred to as assessments mean the application of questions and the application of several forms of problem-solving to see to what extent students understand the learning material or the achievement of student competencies. In the preparation of learning evaluation instruments, a teacher must pay attention to the level of cognitive processes used in the questions. By providing a variety of items with types ranging from LOTS (remembering, understanding, applying) to HOTS (analyzing, evaluating, creating) a complete evaluation instrument will be created.

Physics, which is a branch of science, discusses physical phenomena in nature that are closely related to real life [8]. The use of formulas in every aspect causes a lack of student interest in learning, resulting in low learning outcomes. The basic thing that must be done to improve student learning outcomes is to pay attention to the concepts in physics learning [9]. The results of the preliminary study found at the place of implementation of the field experience program in July - December 2020 semester from the results of the final evaluation of basic competencies material on Elasticity and Hooke's Law basic competencies 3.2 Class XI natural science at SMAN 1 Singingi Hilir, it appears that there is only 1 student who has completed the minimum completeness criteria (70) and the rest ranged from 41 – 69. Meanwhile, the final evaluation results for basic competencies 3.1 ranged from 42 – 79, and from basic competencies 3.3 ranged from 54 – 95. The low student learning outcomes are an indication that students generally have not mastered the existing knowledge. on that subject. So we need a learning device design oriented to the revised Bloom's taxonomy, which becomes a reference for teachers and learning resources for students in improving education.

In line with this, questionnaires and interviews were conducted with teachers in 3 schools with low, medium, and high categories in Kuantan Singingi Regency. It was found that the implementation of the 5M scientific approach was still not optimal. It is shown that there are about 23.65% for the observing aspect, 34.2% for the questioning aspect, 24.78% for the aspect of trying or gathering information, 10.42% for the reasoning and associating aspect, and 6.95 % for the aspect of concluding and communicate. The essential material prepared by the teacher in teaching materials does not evenly contain the 4 dimensions of knowledge. The data obtained is about 21.24% containing factual knowledge, 32.63% conceptual knowledge, 28.45 % procedural knowledge, and

17.68 % metacognitive knowledge. The results of this data analysis revealed that the knowledge provided by the teacher was dominated by conceptual knowledge, then procedural knowledge, followed by factual knowledge and very little metacognitive knowledge. The evaluation instrument for the variation of items (C1 – C6) which was trained for daily tests of students in the evaluation of learning used by the teacher on the material of Elasticity and Hooke's Law Class XI Semester 1 showed that for the six cognitive levels that were trained or tested on questions that showed as many as 18, 51% for the ability to remember, 18.12% for the ability to understand, 19.31% for the ability to apply, 16.71% for the ability to analyze, 16.8% for the ability to evaluate and 9.85% for the ability to be creative. The data shows that higher-order thinking skills (HOTS) such as: analyzing and evaluating are still not optimal, the ability to create is very little.

The results of the field study are also supported by facts from research by Amali Putra in 2015 at a public high school in Padang. It is stated that the quality of student competency achievement in physics learning in SMA in Padang City is still low, in terms of the complexity of the content and the level of cognitive processes are still at levels 1, 2, and 3. While levels 4, 5, and 6 are still very few and almost do not appear. The results of the study recommend developing a learning model that is oriented to the complexity of the content and the level of cognitive processes in high school physics learning in Padang [5]. In line with this, in Santi Asmara's 2020 research it was also concluded that the level of cognitive processes according to Bloom's revised taxonomy at SMAN Padang City trained in teaching materials was the highest 54.28% at the level of applying (C3) and the lowest 0% at the stage of evaluating (C5) and creating. (C6). While the level of remembering (C1) 11.43 %, understanding (C2) 20.96%, and analyzing (C4) 13.33% [2]. From these two preliminary studies, it is known that physics learning in high school still does not use the dimensions of knowledge and levels of cognitive processes optimally so that a learning device design that is oriented to the revised Bloom's taxonomy is needed as a reference for teachers.

To complete the analysis of the need for solutions that must be carried out to solve these problems, the researchers filled out questionnaires and interviews with physics teachers who teach in Class XI Semester 1 (July-December 2020) at 3 schools with different categories (seen from the final accreditation score: sekolah.data.kemendikbud.go.id) in Kuantan Singingi Regency, namely: SMA Negeri 1 Singingi Hilir (91.00), SMA Negeri 1 Singingi (93.00) and SMA Negeri Pintar Riau Province (96.00) [10]. It turns out that some teachers have never attended the 2013 curriculum training and in preparing plans that accommodate the combination of 4 knowledge dimensions and 6 levels of cognitive processes they have no experience. For that, we need an example that will be used as a reference. On this basis, the authors are interested in developing a learning tool oriented to Bloom's taxonomy of elasticity material revisions for physics learning in high school.

II. METHOD

This type of research is Research and Development (RnD) research which is commonly used to develop and validate a research product in the form of a model, design, or implementation of an educational curriculum starting from planning, implementation, to learning evaluation [11]. This development research method is a research method needed to produce or develop certain products and to see the feasibility of the product later. The development model applied is the ADDIE model which stands for Analysis to define a problem so that it can be followed up. Design is the stage to design a product so that the problem can be solved. Development aims to bring the design into reality or a product. Implementation is the stage to apply previously made products and Evaluation which is the last stage to see whether the products made are good and reliable, as expected or not. However, due to the conditions at the time of the Covid-19 Pandemic, the research was only carried out up to stage 3, namely the development stage by 3 lecturers of the Physics Department, FMIPA UNP, and 3 physics teachers in Kuantan Singingi Regency as a team of experts and a team of practitioners.

This research was conducted in Kuantan Singingi Regency using a stratified random sampling technique. There were 3 schools, namely SMAN 1 Singingi Hilir, SMAN 1 Singingi, and SMAN Pintar Riau Province with low, medium, and high categories. As a variable in this study is the scope of 4 dimensions of knowledge and 6 levels of cognitive processes that exist in the document of learning tools prepared by the teacher, including lesson plans, teaching materials, and evaluation instruments.

The research instruments are in the form of a questionnaire sheet for needs analysis as well as instrument validation sheets and product validation sheets for product validation that have been made. The validation data will be processed using the following formula:

$$validation\ value = \frac{sum\ of\ all\ scores}{maximum\ score} x100\% \qquad (1)$$

The assessment criteria as listed in Table 1 below:

Table 1. Likert Scale Validation Criteria

No	Validation Value	Category
1	0% - 20%	Invalid
2	21% - 40%	Not Valid
3	41% - 60%	Quite Valid
4	61% - 80%	Valid
5	81% - 100%	Very Valid

(Source: Ref [12])

The classification of the validity values used in the study is if the average of the expert team and the practitioner team is classified between 61% to 100% with valid and very valid categories.

III. RESULTS AND DISCUSSION

From the research that has been done, it is obtained at each stage of the ADDIE development model as follows:

A. Analysis Stage

At this stage an analysis of physics learning according to the 2013 curriculum in high school is student-centered with the recommended approach is a scientific approach with authentic assessment [5]. This analysis is to look at high school physics learning regarding: a) the implementation of aspects of the scientific approach in lesson plans, b) the fulfillment of the complexity of knowledge in teaching materials and c) the scope of cognitive process levels in evaluation instruments in the field, namely in 3 schools in Kuantan Singingi Regency. So that it is found that the use of aspects of the 5M scientific approach in preparing lesson plans is still not optimal, the coverage of the 4 dimensions of knowledge in teaching materials is still not proportional, and the complexity of the level of thinking processes in evaluation instruments is also still dominant C1 - C4. The data obtained in the field are processed and data is generated in the form of percentages which can be seen in the Table below.

Table 2. The Application Of The 5M Scientific Approach To The Teacher's Lesson Plans

No	Aspects Of The Scientific Approach	School			Average
		SMAN 1 Singingi Hilir	SMAN 1 Singingi	SMAN Pintar Riau Province	
1	Observing	22.77 %	23.53 %	24.66 %	23.65 %
2	Questioning	32.67 %	32.94 %	36.09 %	34.2 %
3	Associating	27.72 %	24.71 %	21.92 %	24.78 %
4	Experimenting	9.9 %	11.76 %	9.59 %	10.42 %
5	Concluding	6.93 %	7.06 %	6.85 %	6.95 %
		Percentage Amount (%)			100 %

From the results of the data in Table 2, it can be seen that the aspects of the scientific approach are not proportional, with the dominating activities being observing, asking questions, and trying while reasoning and communicating are still very few.

Table 3. The Application Of The Knowledge Dimension In Teacher Teaching Materials

No	Knowledge Dimension	School			Average
		SMAN 1 Singingi Hilir	SMAN 1 Singingi	SMAN Pintar Riau Province	
1	Factual	21.05 %	19.35 %	23.33 %	21.24 %
2	Conceptual	28.95 %	32.26 %	36.67 %	32.63 %
3	Procedural	26.32 %	29.03 %	30 %	28.45 %
4	Metacognitive	23.68 %	19.35 %	10 %	17.68 %
		Percentage Amount (%)			100 %

From the results of the data in Table 3, it can be seen that the dimensions of knowledge in teaching materials are not proportional, with the dominant knowledge dimensions being conceptual knowledge, factual knowledge, and procedural knowledge while metacognitive knowledge is still very little.

Table 4. Application Of Cognitive Process Levels In Teacher Evaluation Instruments

No	Cognitive Process Level	School			Average
		SMAN 1 Singingi Hilir	SMAN 1 Singingi	SMAN Pintar Riau Province	
1	Remember	18.13 %	18.82 %	18.59 %	18.51 %
2	Understand	16.37 %	19.41 %	18.59 %	18.12 %
3	Apply	18.71 %	20 %	19.23 %	19.31 %
4	Analyze	17.54 %	15.29 %	17.31 %	16.71 %
5	Evaluate	18.71 %	17.06 %	16.67 %	16.8 %
6	Create	10.53 %	9.41 %	9.62 %	9.85 %
Percentage Amount (%)					100 %

From the results of the data in table 4, it can be seen that the scope of cognitive process levels in the evaluation instrument is not proportional, with the dominant cognitive processes being remembering, understanding and applying while analyzing, evaluating and creating are still very few.

Furthermore, an analysis is carried out to produce the design of learning devices in schools through the following steps: analysis of basic competencies in core competence 3 and core competence 4. Furthermore, basic competencies analysis to produce Competency Achievement Indicators, analysis of learning objectives to produce learning materials based on 4 dimensions knowledge. Finally, the analysis of learning objectives to produce an evaluation instrument based on 6 levels of cognitive processes. Then an analysis was also carried out on the product validation sheet resulting in related indicators in accordance with Bloom's taxonomic theory revised by Anderson and Krathwohl (2001).

B. Design Stage

At this stage, the researcher makes learning tools oriented to the revised bloom taxonomy which is formed in a book consisting of lesson plans, teaching materials, and evaluation instruments. The steps taken by the researcher include: the material chosen is the material of elasticity and Hooke's law in basic competencies 3.2. The reason for choosing this material is because the scope of the material is small, but in the learning process students are still hesitant in issuing opinions to answer teacher questions related to elastic materials. In addition, from the results of the evaluation of students, it is also seen that only a few students have completed, even though in some exercises they are allowed to see the source. Then for the manufacture of learning tools the format of Permendikbud No 22 of 2016 concerning Standard Processes for a lesson plan is used. For teaching materials, the 2008 Ministry of National Education format was used. Meanwhile, the evaluation instrument used an objective test format in the form of multiple-choice by selecting the correct statement and adjusting it according to the options.

The final result of the design developed is a learning tool oriented to Bloom's taxonomy revision of elasticity material for physics learning in high school which is concurrently into a book entitled Physics learning tool oriented to the revised Bloom's taxonomy consisting of lesson plans, teaching materials, and evaluation instruments. The lesson plan includes indicators of competency achievement developed based on the operational verbs in accordance with the level of cognitive processes and dimensions of knowledge, learning objectives, and essential learning materials. In teaching materials, there is the development of the dimensions of knowledge that are in harmony with the essential material. In the evaluation instrument, some questions cover the level of cognitive processes for the assessment of knowledge. While the attitude assessment and attachments are contained in the lesson plan attachment.

C. Development Stage

After completing the design stage, the researcher carried out development to produce a valid product (lesson plan, teaching materials, and evaluation instruments). There are 2 stages of validation, namely instrument validation, and product validation. Instrument validation was carried out by 3 physics lecturers, FMIPA UNP. After the instrument validation is complete, the valid instrument can be used for product validation. The results of instrument validation can be seen in the following Table:

Table 5. Instrument Validation Results

No	Instrument Type	Validation Score			Average	Criteria
		V 1	V2	V 3		
1	Lesson Plan	76.36 %	87.27 %	87.27 %	83.63 %	Very Valid
2	Teaching Materials	78.18 %	90.91 %	92.73 %	87.27 %	Very Valid
3	Evaluation Instrument	80.00 %	90.91 %	81.82 %	84.24 %	Very Valid

It can be seen in table 5 the results of instrument validation by the three lecturers on the lesson plan instrument, teaching materials, and evaluation instruments were considered very valid so that they were declared for trials without revisions.

Product validation was carried out by 6 validators, 3 of whom were physics lecturers at the Faculty of Mathematics and Natural Sciences UNP as experts while the other 3 were teachers who taught class XI high school physics in 3 different schools according to the low, medium, and high categories as practitioners. Before validating, the researcher first shows the results of the design stage to the supervisor for advice and input so that later the product can be submitted to the validator.

1. Lesson Plan

The results of the lesson plan validation related to the 5M aspects of the scientific approach [13]. Obtained from the product assessment developed by a team of experts and a team of practitioners can be seen in the following figure:

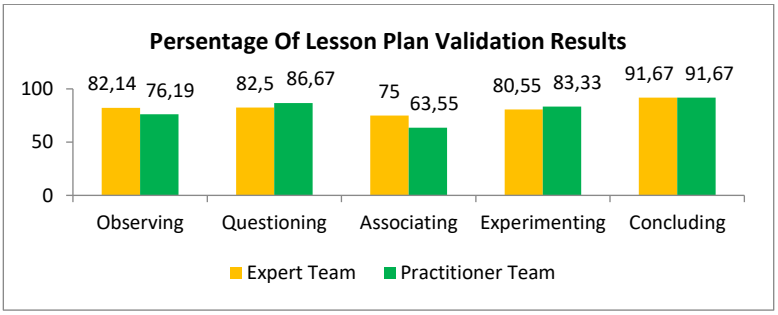

Fig. 1. Lesson plan validation chart

Based on Figure 1, it is known that the results of the lesson plan validation from the expert team scored 82.37% with a very valid category. Meanwhile, 80.39% of the practitioner team were in the valid category. So that the product is feasible to use for high school physics learning.

2. Teaching Materials

In teaching materials, there are several validation assessments related to the analysis of the complexity of content (knowledge), the scope of cognitive process levels, and relating to the fulfillment of aspects of the requirements of teaching materials. In general, all components can be seen as follows:

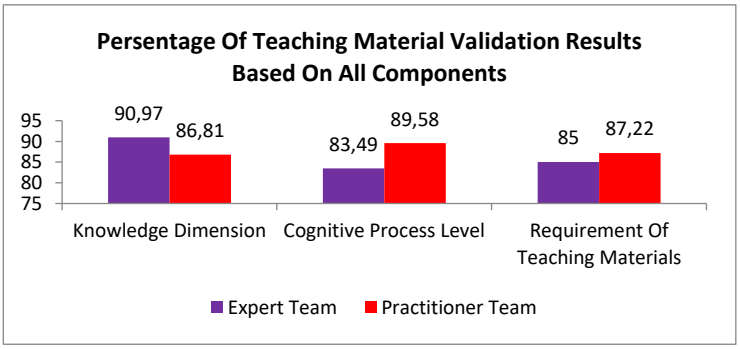

Fig. 2. Graph of the results of the validation of teaching materials based on all components

Based on Figure 2, it is known that the results of the validation of teaching materials as a whole from the expert team got a score of 86.49% with a very valid category. Meanwhile, from the practitioner team, 87.87% were categorized as very valid. So that the product is feasible to use for high school physics learning.

3. Evaluation Instrument

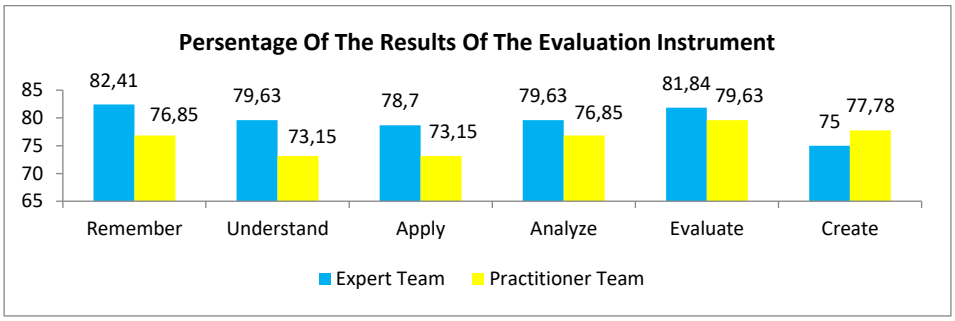

Fig. 3. Graph of the results of the evaluation instrument

Based on Figure 3, the results of the evaluation instrument validation from the expert team got a score of 79.48% with a valid category. Meanwhile, from the practitioner team, 76.24% were in the valid category. So that the product is feasible to use for high school physics learning.

4. Product Validation Results (Learning Device Design)

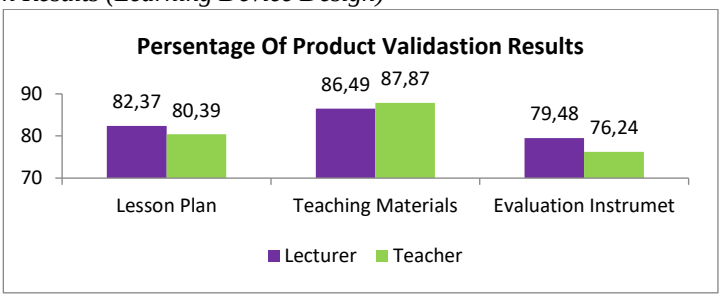

Fig. 4. Product validation result chart

Based on Figure 4, the results of product validation for a lesson plan with an average score of the expert team and the practitioner team of 81.38% with very valid criteria. Teaching materials with an average score of 87,18% with very valid criteria and evaluation instruments with an average score of 77,86% with valid criteria. So that overall the product is feasible to use and ready to be continued for field testing in physics learning in high school.

IV. CONCLUSION

The form of development of learning device design oriented to the revised Bloom's taxonomy of elasticity material for physics learning in high school is in the form of a book entitled physics learning device oriented to the revised Bloom's taxonomy consisting of lesson plans, teaching materials, and evaluation instruments using the format of Permendikbud No 22 of 2016 about process standards and the Ministry of National Education in 2008. The validity of the learning device design oriented to Bloom's taxonomy revision of elasticity material for physics learning in senior high school developed for lesson plans obtained an average validation value of 82.37% lecturers in the very valid category, and the average validation value the teacher's average is 80.39% in the valid category. For teaching materials, the average validation result of the lecturers is 86.49% in the very valid category, and the teacher's average validation value is 87.87% in the very valid category. For the evaluation instrument, the average validation result of the lecturers is 79.48% in the valid category, and the teacher's average validation value is 76.24% in the valid category. In general, this study concludes that the resulting learning device designs are in the category between valid and very valid.

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