

INTEGRATED DESIGN OF KNOWLEDGE DIMENSIONS AND THINKING PROCESS LEVEL ON MEASUREMENT MATERIALS FOR HIGH SCHOOL PHYSICS LEARNING

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ABSTRACT

The learning objectives in the 2013 Curriculum expect changes and improvements in students' competencies. To encourage the achievement of these learning objectives, the learning tools should refer to the Graduate Competency Standards (SKL) which have been regulated in Permendikbud number 20 of 2016. It is explained that the revised Bloom's taxonomy is a reference in developing SKL. The revised Bloom's Taxonomy developed by Anderson and Krathwohl in 2001 categorizes learning outcomes by referring to the dimensions of knowledge and levels of thinking processes. However, the reality is that the intensity of the dimensions of knowledge and the level of thinking processes in learning devices is still not balanced. So, the learning objectives can not be achieved optimally. This study aims to produce a design in the form of a learning device that is oriented to the integration of the dimensions of knowledge and the level of thinking processes. The type of research used is R & D (Research and Development) using a development model, namely the ADDIE model which consists of 5 stages, namely Analysis, Design, Development, Implementation, and Evaluation. In this study, it was only limited to the third stage with valid criteria. The results showed that the learning tools oriented to the integration of the dimensions of knowledge and the level of thought processes were in the very valid category with an overall average value of 3.38.

Keywords : Design; Knowledge Dimension; Thinking Process Level; Measurement Material



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I. INTRODUCTION

Learning in the 21st century, the younger generation is required to master information technology, to be able to adapt to the development of an increasingly advanced era. Therefore, many things must be prepared by the younger generation, ranging from improving how to communicate well, being literate in the use of information technology that has penetrated in various ways, increasing critical thinking in solving problems to creating various things innovatively. This can be trained in line with the teaching and education received by students. Until finally students can compete and be competent in the current globalization in the 21st century. According to the National Education Association, the achievement of success in global competition is marked by the ability of students in skills as communicators, creators, critical thinkers, and collaborators [1][2].

This statement is by following per under the demands of the 21st century in the field of education where it is expected that the learning system must refer to the achievement of learning objectives. The minimum learning objectives that will be achieved are increasing knowledge, changing attitudes, and increasing students' thinking abilities. To see if the 2013 curriculum was implemented well or not, it can be seen in the lessons designed by the teacher. This refers to the Process Standards that have been regulated in Permendikbud number 22 of 2016 and Graduate Competency Standards (SKL) which have been regulated in Permendikbud number 20 of 2016. Implicitly, it is revealed that the revised Bloom's Taxonomy by Anderson and Krathwohl is a reference in the development of planning and implementation of learning [3].

Bloom's revised taxonomy categorizes learning outcomes by referring to the dimensions of knowledge and levels of thinking processes [4]. The knowledge dimension consists of 4 knowledge dimensions, namely factual, conceptual, procedural, and metacognitive. Factual knowledge or also called concrete knowledge is the basic knowledge that students must have to be able to understand and solve certain problems. If basic knowledge forms a concept in a structured and interconnected manner, it is called conceptual knowledge. Procedural knowledge is knowledge about how to do something and how to think about doing something. Metacognitive knowledge or also called abstract knowledge is knowledge about awareness about cognition itself [5]. Meanwhile, the thinking level consists of 6 levels, namely remembering, understanding, applying, analyzing, evaluating, and creating. The three initial levels are included in the low-level thinking category (LOTS), while the final three levels are in the higher-order thinking category (HOTS) [6]. This is also reinforced in a study, that learning that is oriented to the dimensions of knowledge and cognitive processes is valid, effective and efficient to be applied in elementary schools, especially in the learning model achieved. In this study, learning tools such as lesson plans, worksheets and evaluation tools were designed that were oriented to the dimensions of knowledge and cognitive processes [7]. If the dimensions of knowledge and level of thinking can be carried out well in an integrated manner, it can be ascertained that the learning objectives can be achieved. For this reason, the thing that needs to be considered is the extent to which students master knowledge in learning and implementation of the school curriculum.

Based on the results of an interview with a physics teacher at SMA Negeri 1 X Koto Diatas on Wednesday, September 29, 2020, it was concluded that since the launch of the 2013 curriculum, teachers in schools have applied it to the learning process, from learning design to learning evaluation. However, if we look back at the learning objectives, the 2013 curriculum has not been implemented optimally at SMA Negeri 1 X Koto Diatas. Furthermore, observations were made in high schools throughout Solok Regency on learning tools consisting of lesson plans, teaching materials, and assessments. The results of observations on lesson plans on average showed that 25,50% contained the intensity of observing, 29,74% contained the intensity of questioning, 25,71% contained the intensity of trying, 10,74% contained the intensity of reasoning and 8,31% contained the intensity of concluding. This indicates that the intensity of the scientific approach that has been implemented has not been balanced, starting from the design of learning to the evaluation of learning.

Furthermore, the results of observations on teaching materials on average show that 22,47% contains factual knowledge, 34,27% contains conceptual knowledge, 21,63% contains procedural knowledge and 21,63% contains metacognitive knowledge. This indicates that the dimensions of knowledge are not yet balanced. Furthermore, observations were made on the assessment given by the teacher as a task for students to learn. The results of the analysis at the cognitive level that was tested in the form of questions to students showed that 17% was tested for the ability to remember, 22,46% for the ability to understand, 25,85% for the ability to apply, 12,20% for the ability to analyze, 18,70% ability to evaluate, while to create is 3,78%. This indicates that the level of cognitive processes carried out is still not fulfilled properly. This is emphasized again by the fact that teachers are also still not familiar with training students' cognitive levels in material development. Teachers tend to perceive questions with lower cognitive levels as questions with higher cognitive abilities [8].

Based on the interviews and observations that have been made, the overall factors of this problem can be traced by looking at learning as a system that has several components. This system consists of 3 main components including raw input, learning process, and teaching-learning process and output. In this system, there are also 2 components of influencing factors, namely instrumental input factors and environmental input [9]. Of all the components, instrumental input is a very important component, because it is a decisive component in achieving the expected learning outputs/outcomes. With this instrumental input, the learning process can be implemented. Learning devices are one of the instrumental inputs used in a learning system. The learning tools include Learning Implementation Plans (RPP), teaching materials, and assessments. Furthermore, a teacher as a curriculum implementer in planning learning tools is expected to improve student learning achievement so that students benefit in learning [10].

The learning tools used in the 2013 curriculum should have referred to the application of the revised Bloom's taxonomy which combines the dimensions of knowledge and the level of cognitive processes. In addition, the knowledge dimension presented in the learning content (essential material) can improve students' thinking skills. Likewise, the assessment that is tested on students should be developed concerning with reference to the level of the thinking process. Through the development of these two important aspects in the holistic achievement of students' knowledge competencies or learning objectives, if followed by their application in the learning process, it is estimated that the achievement of student competencies will be better [11]. For this reason, it is necessary to understand each level of cognition in the revised Bloom's taxonomy as the basis for developing relevant learning objectives at the each level of cognition [12].

II. METHOD

The type of research used is Research and Development (R & D) using the ADDIE development model [11]. The ADDIE development model describes 5 stages that must be carried out, namely Analysis, Design, Development, Implementation, and Evaluation [13]. Each of these stages can be explained as follows: 1) Analysis, in the form of needs analysis, analysis of target participants, and task analysis; 2) Design, in the form of determining specific goals and designing and creating learning content; 3) Development, in the form of creating and building learning content based on the design stages; 4) Implementation, in the form of real application of learning content; 5) Evaluation, in the form of evaluating the effectiveness of the learning content that has been developed and analyzing how it has been achieved against the learning objectives [14].

The stages carried out in the study are limited to stage 3, with the following modifications: 1) the analysis stage (conducting literature analysis and needs analysis); 2) the design stage (designing the validation instrument sheet, designing materials, and designing learning tools); and 3) development stage (validating learning tools by validators). The research instrument in this study was the initial observation sheet at the analysis stage and the expert validation sheet at the development stage. Expert validation sheets are arranged in the form of questions based on data, literature, and theories related to learning tools oriented to the integration of the dimensions of knowledge and the level of thinking processes. Expert validation sheets compiled include, 1) Learning Implementation Plan (RPP) validation sheets oriented to the dimensions of knowledge and the level of thinking processes; 2) validation sheet of teaching materials oriented to the dimensions of knowledge and the level of thinking processes; and 3) learning assessment validation sheets oriented to the dimensions of knowledge and the level of thinking processes. 2) validation sheet of teaching materials oriented to the dimensions of knowledge and the level of thinking processes; and 3) learning assessment validation sheets oriented to the dimensions of knowledge and the level of thinking processes.

Data processing from expert validation sheets can be measured using a likert scale, as presented in Table 1 below.

Table 1. Likert Scale

Category	Score
Strongly agree	4
Agree	3
Quit agree	2
Do not agree	1

(Source: Modified[15])

The data analysis technique used to see the results of data processing from Likert scale measurements is to add up the values obtained divided by the number of respondents who answered the validation sheet. The average analysis category used to determine the validity level of the learning tools is presented in Table 2 below.

Table 2. Valid Category

Average	Category
3.26 – 4.00	Very valid
2.51 – 3.25	Valid
1.76 – 2.50	Quite valid
1.00 – 1.75	Not valid

(Source: Modified[16])

III. RESULTS AND DISCUSSION

Based on the research that has been done, the results obtained at each stage of the implementation of this research are as follows:

A. Analysis Stage

The first stage carried out is the analysis stage which aims to find out the problems and needs for developing high school physics learning tools for measurement material. At the analysis stage there are 2 steps carried out, namely: 1) analysis of the literature obtained from several studies in the form of theories that support

research, including a) attachment of Permendikbud number 22 of 2016 concerning Process Standards and attachment Permendikbud number 20 of 2016 concerning Graduate Competency Standards (SKL), from the attachment it is revealed that the revised Bloom's taxonomy by Anderson and Krathwohl is a reference in the development of planning and implementation of learning in achieving learning objectives; b) Anderson and Krathwohl's revised Bloom's taxonomic theory, From this theory, it can be stated that if the dimensions of knowledge and the level of thinking processes can be carried out in an integrated manner, then the learning objectives can be achieved. 2) Needs analysis, obtained from interviews and the distribution of observation questionnaires. From the results of the interview, it was explained that since the launch of the 2013 curriculum, school teachers have applied it to the learning process, starting from learning design to learning evaluation. However, if it is reviewed on the learning objectives, the 2013 curriculum has not been implemented optimally. In addition, from the distribution of observation questionnaires, it was revealed that the learning activities in the lesson plan had not balanced the implementation of the scientific approach. In addition, learning materials in teaching materials have not balanced the availability of knowledge, such as conceptual knowledge tends to be more dominant than other knowledge. In the assessment, the level of students' thinking processes has not yet been fulfilled. It can be seen that the ability to analyze is still very little in the questions that are trained, as well as the ability to evaluate and be creative. As a result, students can only be able to remember that is temporary. Therefore, it is necessary to make efforts in balancing the dimensions of knowledge and the level of thinking processes in learning tools. students can only be able to remember that is temporary. Therefore, it is necessary to make efforts in balancing the dimensions of knowledge and the level of thinking processes in learning tools. students can only be able to remember that is temporary. Therefore, it is necessary to make efforts in balancing the dimensions of knowledge and the level of thinking processes in learning tools.

B. Design Stage

At the design stage, there are 3 steps, namely: 1) the design of the research instrument sheet. This sheet is a validation sheet for lesson plans, teaching materials, and assessments. The purpose of designing this validation sheet is as a reference in evaluating the development of learning tools. The questions on the validation sheet are designed based on a literature review and theories related to learning tools that are oriented towards the integration of the dimensions of knowledge and the level of thinking processes. 2) The design of measurement materials starts from indicators of competency achievement, learning objectives, and essential materials which will later become the main ingredients in designing learning tools. Each component that is designed refers to the integration of the dimensions of knowledge and the level of thinking processes. 3) Design of learning devices that include lesson plans, teaching materials, and assessment. The draft lesson plan contains the preparation steps, including a) reviewing the syllabus; b) analyze the relationship between SKL, KI, and KD; c) determine the time allocation for each meeting; d) formulating learning objectives; e) compiling learning materials; f) determine the appropriate approach/model/method; g) determine the media, tools, materials used in the learning process; h) ensure relevant learning resources; i) describe the learning steps, and j) developing assessment processes and learning outcomes [17]. The design of teaching materials contains steps, namely: a) title; b) study instructions; c) competencies to be achieved; d) content of the material; e) tasks; and f) evaluation [18] Meanwhile, the assessment design contains steps for preparing HOTS questions, including a) analyzing KD; b) compiling a grid of questions; c) choosing the right and contextual stimulus; d) write the question items according to the question grid, and; e) create scoring guidelines or answer keys [19].

C. Development Stage

At the development stage, validation will be carried out on the design of learning tools that are oriented towards the integration of the dimensions of knowledge and the level of thinking processes. Validation was carried out by 3 lecturers and 3 physics teachers after being approved by the supervisor. The following is a description of the results at each stage of development, including:

1) Instrument Sheet Validation Results

The instrument sheet validation contains the average feasibility score from the RPP validation instrument sheet, teaching materials, and assessments, as shown in the following figure.

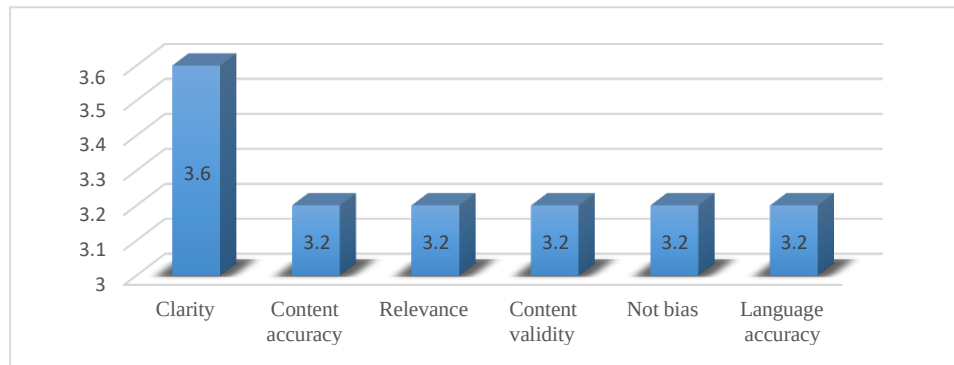


Fig.1. Graph of feasibility score of research instrument sheets for RPP validation

The graph above shows that the mean score of the feasibility of the research instrument sheet for RPP validation is very valid with an average of 3.3. So it is feasible to use for validation of physics learning devices on measurement material.

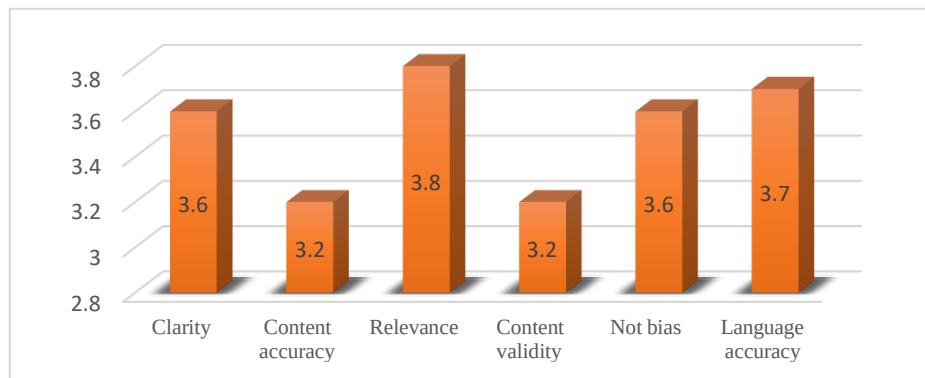


Fig.2. Graph of feasibility score of research instrument sheets for validation of teaching materials

The graph above shows that the mean score of the feasibility of the research instrument sheet for the validation of teaching materials is very valid with an average of 3.3. So it is feasible to use for validation of physics learning devices on measurement material.

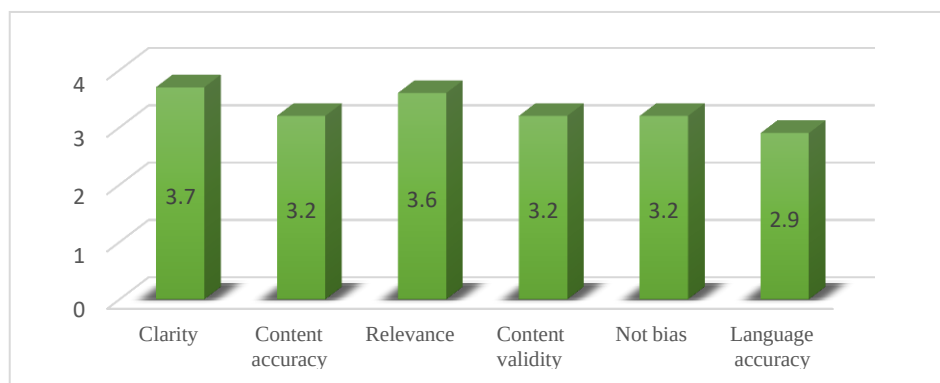


Fig.3. Graph of feasibility score sheet for research instruments for assessment validation

The graph above shows that the mean score of the feasibility of the research instrument sheet for assessment validation is very valid with an average of 3.3. So it is feasible to use for validation of physics learning devices on measurement material.

2) Learning Tool Validation Results

Following are the validation values for each learning device, including:

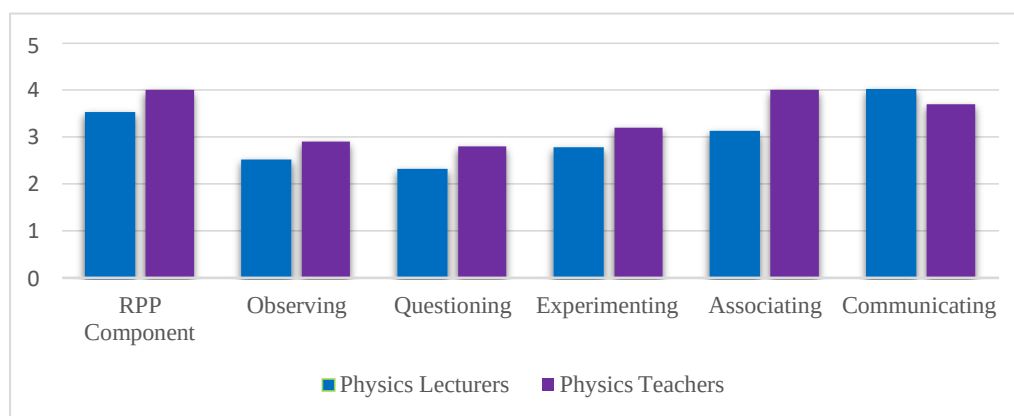


Fig.4. Average results of RPP validation judging from the availability of scientific approach

The graph above shows that the mean of RPP validation in terms of the availability of a scientific approach is valid with a value of 3.06 from physics lecturers and 3.40 from physics teachers. So that the average of both is 3.23 and is suitable for use in learning physics.

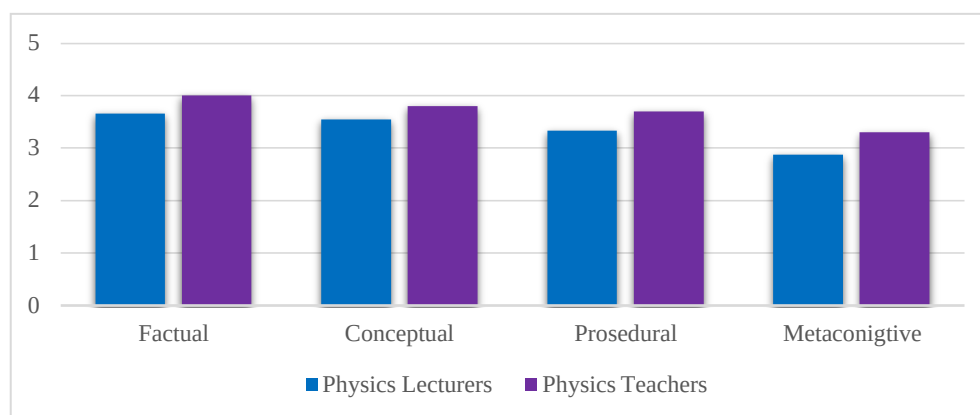


Fig.5. Average results of teaching material validation in terms of the complexity of the knowledge dimension

The graph above shows that the average result of the validation of teaching materials in terms of the complexity of the knowledge dimension is very valid with a value of 3.34 from physics lecturers and 3.70 from physics teachers. So that the average of both is 3.52 and is suitable for use in learning physics.

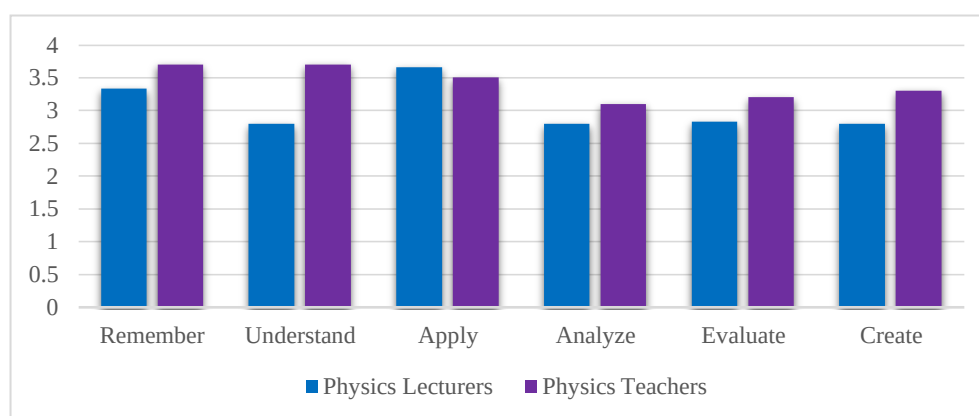


Fig.6. The average results of the validation of teaching materials in terms of the thinking process level

The graph above shows that the average results of the validation of teaching materials in terms of the complexity of the thinking process level are valid with a value of 3.03 from physics lecturers and 3.40 from physics teachers. So that the average of both is 3.21 and is suitable for use in learning physics.

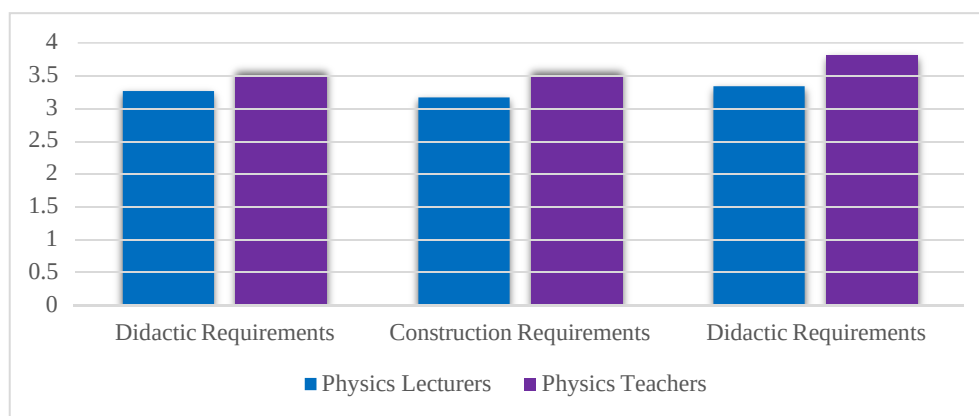


Fig.7. Average results of teaching material validation in terms of aspects of teaching material requirements

The graph above show that the average results of the validation of teaching materials in terms of the requirements of teaching materials are very valid with a value of 3.25 from physics lecturers and 3.70 from physics teachers. So that the average of both is 3.47 and is suitable for use in learning physics.

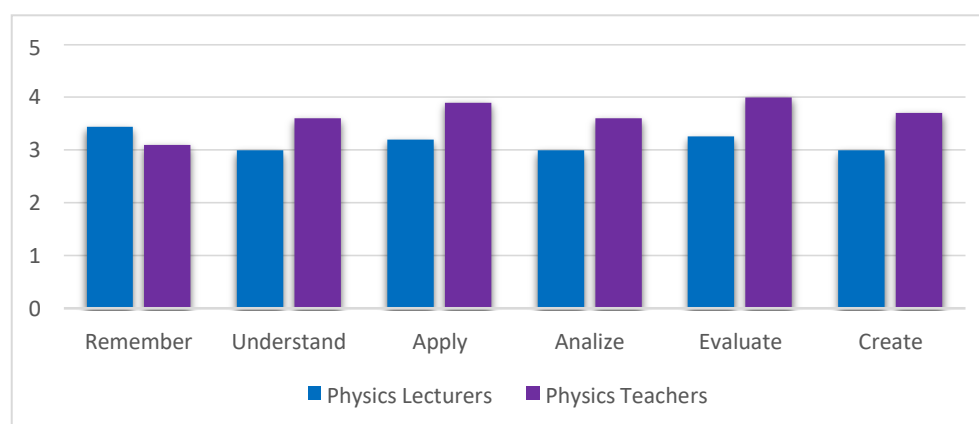


Fig.8. Average assessment validation results in terms of thinking process level

The graph above show that the mean of the assessment validation results in terms of the level of the thinking process is very valid with a value of 3.14 from physics lecturers and 3.70 from physics teachers. So that the average of both is 3.42 and is suitable for use in learning physics.

IV. CONCLUSION

Based on the results of the development and research that has been carried out, it is concluded that learning tools are arranged based on the reference dimensions of knowledge and levels of thinking processes contained in the revised Bloom's taxonomy by Anderson and Krathwohl can be used in implementing learning by the 2013 curriculum. knowledge and level of thinking process on measurement material in high school physics learning are in the very valid category. The average value of the validation of learning tools is 3.38.

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