

## CONCEPTUAL MODEL APPLICATION OF KNOWLEDGE DIMENSION COMPLEXITY AND COGNITIVE PROCESS LEVEL IN STATIC FLUID MATERIALS IN HIGH SCHOOL

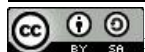
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### ABSTRACT

The 2013 curriculum mandates the implementation of learning activities by referring to Bloom classification revised by Anderson and Krathwohl (2001), which combines knowledge dimensions and cognitive process levels. However, the complexity of the knowledge dimension and the realization of the cognitive processing level in static fluid materials have not been optimally realized. This research aims to establish a conceptual model of the complexity of the knowledge dimension and cognitive process level of static fluid materials in high school physics learning. The research type is R&D research carried out by the ADDIE development method, which boils down to the development phase. The subjects were three faculty members of the Department of Physics FMIPA UNP and three physics teachers at Merangin Regency State High School, including SMAN 3, 6, and 17 Merangin. The topic is learning tools (RPP, textbooks, and assessment tools) based on knowledge dimension and cognitive process level in a static liquid material of high school physics class. The expert group's research and application results on the knowledge dimension complexity and cognitive process hierarchical conceptual model composed of teaching plans, teaching materials, and evaluation tools were 0.71, and the practitioner group was 0.87. The resulting degree of learning device verification average value is 0.79, so it can be classified as effective and practical to test the effectiveness and practicality of this field.

**Keywords** :Complexity, Knowledge Dimensions; Cognitive Process Levels; Learning Tools; Static Fluids.



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## I. INTRODUCTION

Industrial revolution 4.0 is a system that allows for an automatic response using digital technology. For a better life, it is necessary to improve the quality of self by each individual[1]. The revised 2013 curriculum is one of the efforts made by the government to face the industrial revolution 4.0 through education[2].

The study should refer to Bloom classification method by Anderson and Krathwohl (2001) to achieve the expected ability. The revised Bloom classification is a combination of four knowledge dimensions and six cognitive process levels. Dimensions of knowledge include factual knowledge, conceptual knowledge, procedural knowledge, metacognitive knowledge[3]. The level of cognitive processes discussed is the ability to remember (C1), understand (C2), apply (C3), analyze (C4), evaluate (C5), and create (C6) [4], [5]. Educators should pay attention to the combination of the dimensions of knowledge and the level of cognitive processes in planning, implementing, and evaluating learning to increase student knowledge in line with increasing thinking skills.

Learning tools are all learning support components used by teachers to give to students in the learning process, which can be in the form of syllabus, lesson plans, worksheets, assessments or learning outcomes tests, and learning media [6]. RPP consists of: based on school identity, subjects, competencies, goals to be achieved, learning steps, and assessment materials. The ability index is formulated in lesson plans and compiled with the help of action verbs according to cognitive processing level and range of knowledge dimensions. The formulation of learning objectives using metrics, taking into account the principle of ABCD+K, where K stands for (knowledge) [7]. Teaching materials used in learning should guide teachers and students to facilitate the learning

process in understanding the material and a reference for evaluating the learning process [8]. An assessment tool, or what is commonly referred to as an assessment, involves the use of questions and the application of multiple forms of problem-solving to understand a student's level of understanding of a topic or achievement of a student's ability[7].

Physics is a branch of science that studies the components of matter that interact with each other[7]. According to Ramadiani and Anomaisa (2001), physics is a branch of science that studies something concrete and can be proven by equations and scientific experiments[9]. Physics is one of the subjects that are often said to be difficult for students to understand. Students' difficulty in learning physics at school is that in the process of learning physics many formulas are difficult to understand and apply[10]. When students have to choose a suitable formula to solve physics problems, students will find it difficult. The difficulties felt by students caused a decrease in students' interest in learning physics, so that it had an impact on student learning outcomes.

One of the physics learning materials considered problematic in terms of understanding concepts is static fluids. Students' inadequate understanding of concepts affects the occurrence of problem-solving errors. Therefore, it is necessary to understand the reasons for the low level of students' knowledge. Errors in solving issues that students often experience are errors in determining hydrostatic pressure, absolute pressure, the weight of objects in a fluid, and buoyancy[11]. For this reason, it is necessary to make improvements to solve the problems faced by students.

The actual situation in the field is based on the author's experience when carrying out the Educational Field Practice in the area of Physics in class XI of the Science Department at SMA Negeri 3 Merangin during the July-December 2020 semester, the mastery of student knowledge in learning so far has not achieved the expected results. Based on field studies, daily assessments (PH) on static fluid subjects have a lower level of knowledge mastery than other subjects. The data can describe in Table 1

**Table 1.** PH Data For Class XI Physics Subjects For The 2020/2021 Academic Year

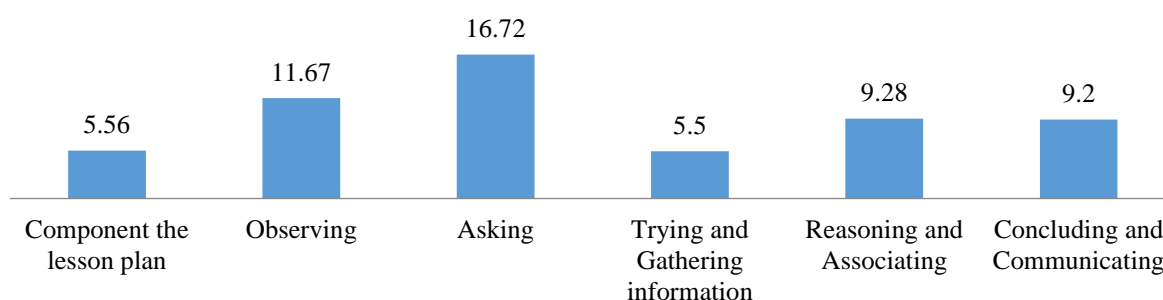
School	Class	Equilibrium liquid body			Hooke's law			Static Fluid		
		Max	Min	Average	Max	Min	Average	Max	Min	Average
		SMAN 3 Merangin	MIA 1	94	57	78,4	96	80	87,7	96
SMAN 6 Merangin	MIA 1	90	60	75,5	95	72	85,6	88	60	74,6
SMAN 17 Merangin	MIA 1	90	40	75,2	97	75	86,3	90	50	74,3

(Source: Physics teacher at SMAN 3,6,17 Merangin)

Based on Table 1, the static fluid material has the highest value, the lowest value, and a smaller average value compared to other subjects. This shows that mastery of static fluid material needs to be further developed. To this end, it is necessary to understand the reasons why the level of students' knowledge is low.

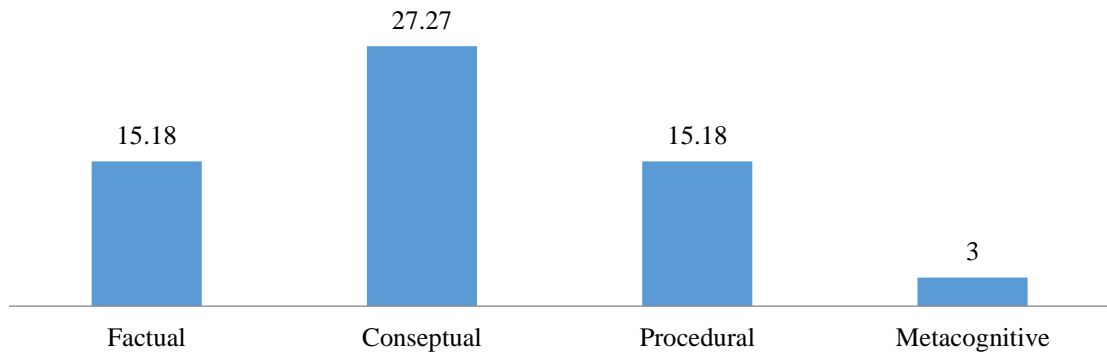
To find out the problems that led to the low level of student knowledge, the researchers conducted observations and interviews with physics teachers representing the lower three types of Merangin Regent High School. SMAN 3 Merangin represented the high school category, the medium type was SMAN 6 Merangin, and the low sort was SMAN 17 Merangin. The results of research conducted by researchers can be detailed as follows:

First, the results of observations on implementing the 5M scientific approach have not been appropriately implemented. This is illustrated by the lesson plans made by the teacher. The implementation of the scientific approach in schools can be explained in Figure 1.



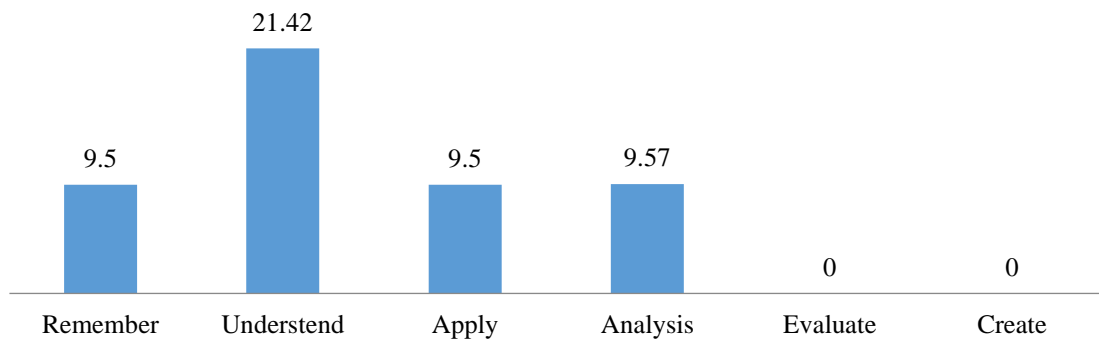
**Fig.1.** Graph of the percentage of willingness to scientific approach in teacher's RPP

Secondly, the teaching material does not cover the dimension of knowledge to the maximum extent. Textbooks are still dominated by facts and concepts, and procedural knowledge and metacognitive knowledge are scarce. It affects students' ability to think at higher levels. It can describe in Figure 2.



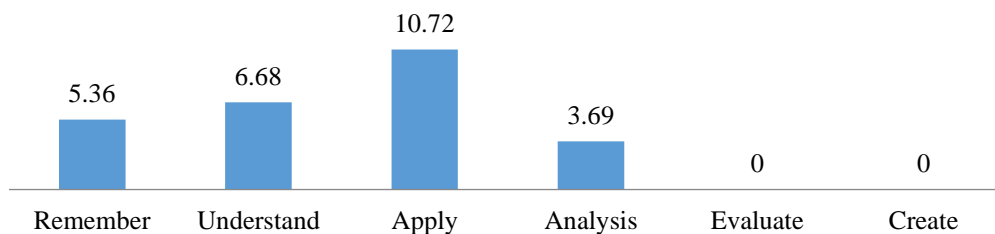
**Fig. 2.** Graph of percentage knowledge dimension willingness on teaching materials in schools

Third, the teaching material does not cover the level of the cognitive process well. The teaching materials still focus on memory, comprehension, application abilities, and activities such as analysis, evaluation, and creation are still invisible. It can describe in Figure 3.



**Fig. 3.** Percentage of willingness of cognitive process levels in teaching materials in schools

Fourth, the evaluation instruments that were trained to students have not been made correctly. The evaluation instrument is still dominated by remembering, understanding, applying, and analyzing exercises while evaluating and creating has not been seen. This can be seen in Figure 4.



**Fig. 4.** Proportion of cognitive process levels in evaluation instruments in schools

Fifth, interviews with three subject teachers in the Merangin Regency concluded that teachers still need knowledge dimensions and cognitive process learning tools references to improve students' sequential reasoning ability. Learning tools discussed include lesson plans, teaching materials, and assessment tools.

The preliminary study conducted by the researchers are consistent with a previous study conducted by Amali Putra at SMAN in Padang City in 2015. The conclusion from the perspective of the complexity of the physics curriculum and the level of cognitive processing, the ability of the students in the physics curriculum of Padang National Middle School is still very lacking, and most of them are still in the 1st, 2nd, 3rd, and 4th grades. Levels

5 and 6 are still rare. And tend not to recommend the development of learning models based on content complexity and cognitive process levels to improve the abilities of SMA Negeri physics students in Padang City.[12]. In line with that, Sri Fatmawati in 2013 stated that the development of learning objectives and activities as well as physics questions still need to be improved to help teachers understand Bloom's revised taxonomy correctly[13].

## II. METHOD

The type of research following the problems and objectives stated is an analysis using research and development (R&D) methods. R&D is a research method used to produce specific products and test the effectiveness of certain products[14]. The research type is R&D research carried out by the ADDIE development method, which boils down to the development phase. The subjects were three faculty members of the Department of Physics FMIPA UNP and three physics teachers at Merangin Regency State High School, including SMAN 3, 6, and 17 Merangin. The topic is learning tools (RPP, textbooks, and assessment tools) based on knowledge dimension and cognitive process level in a static liquid material of high school physics class. Tools used in this study, namely interview guidelines used for field needs analysis conducted for physics subject teachers and validation instruments used by lecturers and practitioners team to assess the learning tools developed. The validation result of learning tools by an experts team and a practitioners team were then analyzed using Aiken's V (V) index with the equation:

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

$$s = r - l_0 \quad (2)$$

The percentage category can describe in table 2 below.

<b>Interval</b>	<b>Category</b>
$0,8 < V$	High
$0,4 < V \leq 0,8$	Currently
$V \leq 0,4$	Not Enough

(Source: Reff[15], [16])

## III. RESULTS AND DISCUSSION

The research was conducted through 3 stages of ADDIE development, namely Analysis, Design, and Development. The analysis phase includes initial analysis, field analysis, and literature analysis. Preliminary studies were conducted to determine product development needs by analyzing previous research articles related to research variables. As for the initial research results, it is necessary to develop learning tools oriented to the complexity of the dimensions of knowledge and the level of cognitive processes in learning.

Field studies have conducted the implementation of knowledge dimensions and the level of cognitive processes in learning was determined through observations and interviews with physics teachers. The result observations on the performance of the scientific method, the availability of knowledge dimensions, and the level of cognitive processes of the learning devices used in schools can see in Figures 1, 2, 3, and 4. The results of interviews with teachers of physics subjects show that teachers still need to develop learning tools that include the knowledge dimension and cognitive process level. The results of the interview with the physics subject teacher showed that the development of learning tools that contained the dimensions of knowledge and levels of cognitive processes was still needed by the teacher, besides it was known that in static fluid material, there were still many students who did not understand the material, causing learning outcomes for static fluid material to be lower than the material, which can be seen in table 1. The literature study aims to examine the theoretical basis that supports research so that the resulting learning devices can comply with applicable rules.

The design phase is carried out to create a design of the learning device to be developed. The learning tools generated from this research are lesson plans, teaching materials, and assessment tools that address the complexity of knowledge dimensions and the level of cognitive processes. The developed learning material is static fluids. The selection of static fluid material in the development of learning tools is made because the material contains

several concepts. Many students are confused about it and impact the lower pH of the static fluid compared to the previous material.

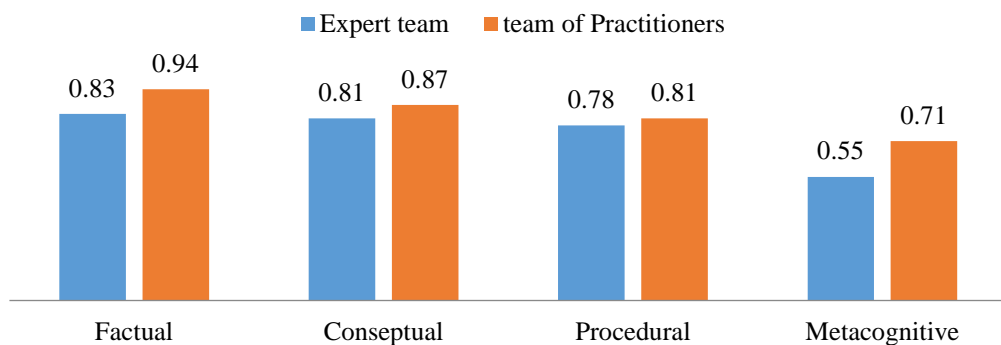
The development stage is carried out to make learning tools that will be developed according to the plan at the design stage. The learning tools developed are then given to the validator consisting of experts and practitioners team to be given advice and assessed for practicality. Product revisions are carried out by the suggestions given by the validator at the validation stage so that the resulting product becomes better.

The result of development is a learning device validation sheet, which contains knowledge dimensions and cognitive process levels in static, flowing material, including 1) Competency Performance Indicators (GPAs); 2) Learning Objectives (TPs); 3) Lesson Plans (RPP); 4) Instructional Materials; and 5) Assessment Tools. The resulting GPA uses a 4x6 matrix model of KKO revised based on Bloom classification. The learning objective consists of ABCD+K. Validation of lesson plans based on the implementation of the scientific approach can be explained in Figure 5.



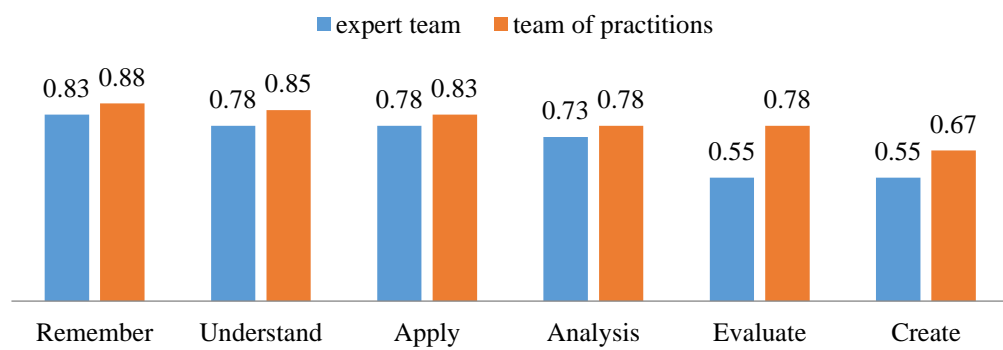
**Fig. 5.** RPP validation results base on the implementation of a saintifik approach

Based on Figure 5. The results of RPP development related to implementing the 5M approach have an average value of RPP validation according to the expert team, which is 0,74. In contrast, the average practicality value according to the practitioner team is 0,9. The results of validating all components and aspects of the 5M in lesson plans according to experts team and practitioners team are considered valid and feasible to be used for field trials. The results of the validation of the knowledge dimension in teaching materials can be seen in Figure 6



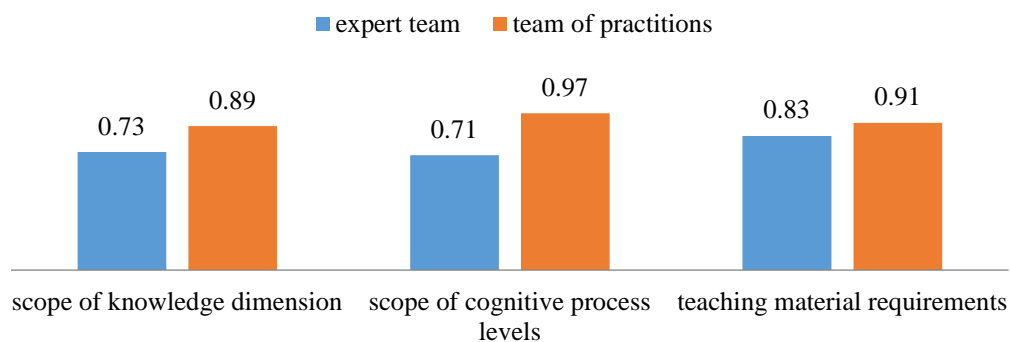
**Fig. 6.** Results of validation of knowledge dimension analysis in teaching materials

Based on Figure 6. According to the expert team, the development of the dimensions of knowledge has an average value of 0,71 while according to the practitioner team, it is 0,83. The validation and practicality of the knowledge dimension in teaching materials according to experts and practitioners team are considered very valid and feasible to be used for field trials. The validation result of cognitive processes in teaching materials can be seen in Figure 7.



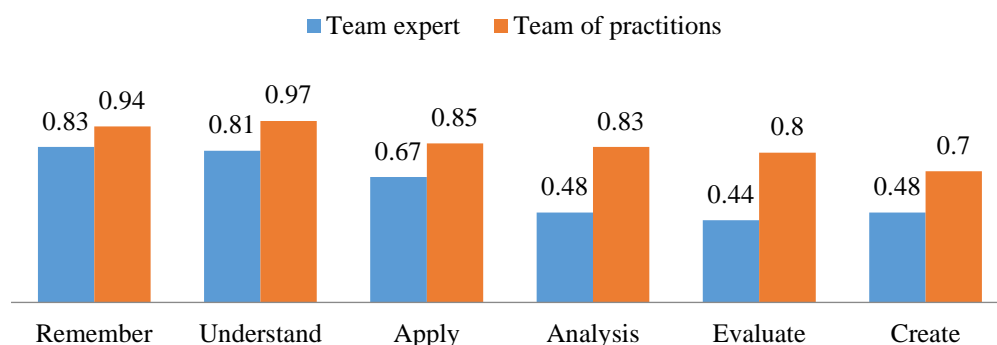
**Fig. 7.** Results of validation of cognitive processes analysis in teaching materials

The level of cognitive processes in teaching materials has an average value according to the expert team of 0,71 while according to the practitioner team, it is 0,80. The validation and practicality of cognitive processes in teaching materials according to experts and practitioners team are considered valid and feasible to be used for field trials. Results of validation based on dimensions of knowledge and cognitive processes in teaching materials see in Figure 8.



**Fig. 8.** Results of the validation of dimensions of knowledge and cognitive processes in teaching materials

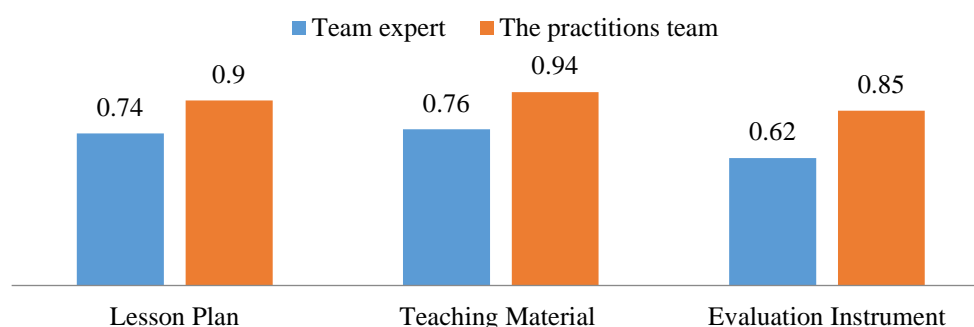
Based on Figure 8. According to the expert team, the development of the dimensions of knowledge and the level of cognitive processes in teaching materials has an average value of 0,76. In comparison, according to the practitioner team, it is 0,92. The validation and practicality of dimensions of knowledge and cognitive processes in teaching materials according to experts and practitioners team is considered very valid and feasible to be used for field trials. Results of validation based on cognitive processes on the evaluation instrument see in Figure 9



**Fig. 9.** Results of the validation cognitive processes on evaluation instrument

Based on Figure 9. The development of the cognitive process level on the evaluation instrument has an average value according to the expert team of 0,62 while according to the practitioner team, it is 0,85. The validation and practicality of cognitive processes on evaluation instruments according to experts and practitioners team are considered very valid and feasible to be used for field trials. Overall, the results of the validation of

learning tools oriented to the dimensions of knowledge and the level of cognitive processes are described in Figure 10.



**Fig. 10.** Results of the validation of learning tools oriented to the dimensions of knowledge and the level of cognitive processes

Based on Figure 10. According to the expert team, learning tools oriented to the dimensions of knowledge and the level of cognitive processes have an average value of 0,71. In comparison, according to the practitioner team, it is 0,9. According to a team of experts and a team of practitioners, the validation and practicality learning tools' results are 0,81 so it was considered very valid and feasible to be used for field trials.s

#### IV. CONCLUSION

The validity of the conceptual model of the knowledge dimension and the cognitive process level of the expert team was 0.71. That compares to 0.9, according to team practitioners. The average result for the validation and practical value of learning tools that incorporate knowledge dimension complexity and cognitive process level in static liquid materials is 0.81. It can be classified as very effective and can test the validity and practicality of the field.

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