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Development of Test Instruments Based on Cognitive Processes and Knowledge Dimensions on Environmental Chemistry

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Abstract: This research aims to develop an instrument that can measure the achievement of student learning outcomes in chemistry education in Environmental Chemistry courses, which refers to Bloom's Taxonomy, which has been revised along with the dimensions of knowledge from Anderson & Krathwohl. The research method used in this research is research and development with 4 (four) stages of research 1) define; 2) design; 3) develop; and 4) dissemination. The validation of this instrument was carried out by two experts in the field of chemistry and tested on 20 students. The instrument used is in the form of a description that takes the cognitive domains C1 to C3. In addition, in the instrument there are also 4 (four) dimensions of knowledge tested, namely factual, conceptual, procedural, and metacognitive. Based on the results of expert validation, it was found that in content there were no problems only in the use of verbs in the instrument requiring more operational verbs and based on the test results it was found that all the questions given showed that 30.15% of the questions were categorized as easy, 44, 80% were categorized as moderate and 25.05% were categorized as difficult. This study shows that the knowledge dimension in Bloom's taxonomy needs to be applied by considering the knowledge dimension to develop thinking skills in students.

Keywords: Anderson-Krathwohl; Cognitive domain; Bloom's taxonomy; Test preparation

Introduction

Bloom's Taxonomy is a model that is generally used to determine the characteristics of student learning outcomes. According to (Bloom et al., 1956) the purpose of learning is to explicitly formulate the expected ways in the objectives of the learning process. Bloom's taxonomy has been revised, in the new version there is a separation between the knowledge dimension and the cognitive process dimension. In the old version, the knowledge dimension is included in the lowest cognitive domain, while in the new one, knowledge is separated from the cognitive process dimension. In addition, knowledge is a noun while the cognitive process is a verb (Widodo, 2006). An explanation of the knowledge dimension in Bloom's taxonomy can be seen in table 1.

Langdon et al. (2019) state that cognitive knowledge includes declarative, procedural, and conditional. Declarative is knowledge of facts and concepts, procedural is knowledge of procedures, and conditional is knowledge of condition.

In general, the measurement of learning outcomes that have been carried out refers to the dimensions of the cognitive domain from Bloom's taxonomy which is commonly known as the letter C which means "cognitive". This C starts from C1 to C6. Dimensions in this cognitive domain start from C1 (memorization); C2 (understand); C3 (apply); C4 (analyze); C5 (evaluate); and C6 (make) (Krathwohl, 2002). Very rarely does

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research discusses the dimensions of knowledge in Bloom's taxonomy. Therefore, this study will develop questions that focus on these dimensions.

In Bloom's taxonomy, the first level is "Knowledge", and at this level, the task or activity referred to as "define" involves the student's ability to provide a definition or explanation of a concept or object. (Ullah et al., 2020). Students are expected to be able to detail or give a clear picture of something. In this context, defining involves more than just remembering information, but also understanding and being able to communicate the meaning of a concept in one's own words. This ability is the first step in building a deeper understanding of the subject matter (Qasrawi & Beniabdelrahman, 2020).

Table 1. Knowledge Dimensions of Bloom's Taxonomy

Dimensions of Knowledge	Explanation	Kinds of Knowledge
Factual Knowledge	Knowledge in this dimension is a piece of information that is separate from the basic elements that exist in a particular discipline. This knowledge is a low-level abstraction	1) Knowledge of terminology, 2) Knowledge of detail parts and elements
Conceptual Knowledge	The knowledge that shows the interrelationships between basic elements in a larger structure that all function together. This knowledge includes schemas, thought models, and theories both implicitly and explicitly	1) Knowledge of classifications and categories, 2) Knowledge of principles and generalizations, 3) Knowledge of theories, models, and structures
Procedural Knowledge	Knowledge of how to do something both routine and something new. This knowledge usually contains steps or stages that must be followed in doing a certain thing	1) Knowledge of special skills related to a particular field and knowledge of algorithms, 2) Knowledge of techniques and methods related to a particular field, 3) Knowledge of criteria to determine when a procedure is appropriate to use
Metacognitive Knowledge	This knowledge is about cognition in general and knowledge about oneself.	1) Strategic knowledge, 2) Knowledge of cognitive tasks, 3) Knowledge of self

Identifying involves students' ability to recognize or name certain information. It includes students' ability to remember and acknowledge important facts, concepts, or elements of a topic without the need to provide definitions or explain further (Aninditya et al., 2019). In this situation, students are asked to acknowledge or name something they have learned, but are not asked to provide an in-depth understanding or detailed explanation of the material (Ridvan et al., 2014). This is the initial level in the development of understanding and mastery of basic concepts (Oktaviana & Susiaty, 2020).

In the context of Bloom's Taxonomy, the level of "Knowledge" (Knowledge), identifying involves a student's ability to recognize or name certain information. It includes students' ability to remember and acknowledge important facts, concepts, or elements of a topic without the need to provide definitions or explain further (Pujawan et al., 2022). At the application level, students are not only tested on comprehension and memory, but also on their ability to take the information they have learned and apply it in different contexts. It involves being able to apply knowledge in practical situations and demonstrating a deeper understanding of how the concepts can be used in everyday life or in work contexts (Crompton et al., 2019).

The "Analysis" degree includes students' ability to understand the elements of a concept or information and decipher how those elements relate to each other (Bibi et al., 2020). Students are expected to analyze information by breaking it down into smaller parts, identifying relationships, and understanding the overall structure (Gul et al., 2020). At the analysis level, students are given the opportunity to develop a deeper understanding of the structure and organization of concepts, as well as be able to demonstrate their ability to break down complex information into simpler components. These analytical skills provide a foundation for a deeper and critical understanding of the learning material (Ahmed et al., 2023).

The "Evaluation" level involves a student's ability to make judgments or decisions related to a given information, argument, or situation (Tuma & Nassar, 2021). Students are expected to be able to evaluate information by detailing advantages and disadvantages, make judgments based on certain criteria, and develop critical thinking (Aryawan et al., 2023). At the evaluation level, students are not only able to analyze information, but can also provide judgments or make decisions supported by their critical thinking. It involves being able to measure the value or significance of a concept, idea, or action. These evaluation abilities reflect a higher level of cognitive expertise in Bloom's taxonomy (Nascimento et al., 2021).

The highest level includes the student's ability to combine the elements learned into a new whole.

Students are expected to organize and integrate information, concepts, or ideas into new, more complex structures or forms (Chandio et al., 2021). At the synthesis level, students are at the stage of creativity, where they not only understand and apply concepts, but are also able to compose them into a unique or original form. It involves the ability to think abstractly, see relationships between different elements, and create something more complex or better than it has come before. The synthesis reflects a high level of cognitive expertise in Bloom's Taxonomy (Pikhart & Klimova, 2019).

The development of the questions carried out in this study took environmental chemistry material. Prospective chemistry teachers are guided to master chemistry in three main aspects: concept, context, and application. Apart from that, they also need to understand the important role of chemistry in the environment, its impact on the environment, as well as solutions to overcome these environmental problems caused by chemicals, therefore environmental chemistry material is something that is needed by chemistry education students (Nuswowati, 2012). In addition, environmental education is also an important factor in achieving success in environmental management, being a very important means in producing human resources who can implement the principles of sustainable development. The development of questions on the dimension of knowledge is carried out to find out how the dimensions of knowledge possessed by students are not only related to the dimensions of cognitive processes. According to Clark et al. (2019), all advanced science is based on good measurement and psychology needs to double down on developing good and valid measurements. Through this research, it is hoped that there will be an instrument that can measure both types of dimensions in Bloom's taxonomy so that the results provided can fully describe what is in the minds of these students regarding environmental chemists.

Method

The research method used in this study adopted the research and development steps of Thiagarajan et al. (Ntobuo et al., 2018) which consists of 4 (four) stages or known as 4D, namely 1) define; 2) design; 3) develop; and 4) dissemination. The define stage is carried out by defining the learning objectives to be achieved through environmental chemistry courses; the design stage in this study was carried out through the adjustment of the instrument developed based on Bloom's taxonomy which had been revised by taking into account cognitive processes and knowledge dimensions; the development stage is carried out by developing a new instrument design through a validation process carried out by 2 experts to get input and improvements to the developed instrument. In the last stage or dissemination, a trial process what had been developing research.

Result and Discussion

Define Stage

This section will explain in detail the implementation of the four stages of research that have been mentioned previously on the research method. The explanation will be explained sequentially according to the 4D stage.

Define Stage

At this stage, the researcher determines the purpose of the lecture process that has been carried out to get an overview of student mastery of environmental chemistry. Based on the results of discussions with the lecturers of this course, it was found that there are 6 (six) lecture objectives that must be achieved by students, namely: a) assess the impact of global warming, the greenhouse effect, and the depletion of the ozone layer. b) Analyzing the occurrence of acid rain and environmental pollution (air pollution). c) Analyzing the causes of water pollution. d) Summing up the causes of pollution in the soil. e) Biodegradable toxicology, carcinogenesis, and a serious waste. f) Mention the use and danger of radioisotope radiation for living things and the environment.

Design Stage

The preparation of questions/tests based on Bloom and Anderson – Krathwohl taxonomy is used in learning through student work. The research was conducted on distance higher education providers for environmental chemistry courses. The test is given after students are given Environmental Chemistry learning. The preparation of the question concerns learning objectives, teaching materials provided and test grids referring to learning outcomes. Before being given a test, students are given learning and reading materials or modules related to topics that are by the learning objectives to be achieved.

The subjects involved in this study were 2 tutors as material developers, 2 experts as reviewers/material experts, and 20 students. The level of ability carried out includes 6 cognitive aspects of Bloom, namely: remembering, understanding, applying, analyzing, evaluating, creating, along with four dimensions of knowledge, namely factual, conceptual, procedural, metacognitive, as shown in Table 2. The data obtained were analyzed descriptively qualitatively.

Table 2. Cognitive Dimension Chart and Cognitive Process

		Cognitive Process					
		C1 Remembering	C2 Understanding	C3 Apply	C4 Analysis	C5 Evaluate	C6 Create
Dimension of know-ledge	Factual	C1 Factual	C2 Factual	C3 Factual	C4 Fakcual	C5 Factual	C6 Factual
	Conceptual	C1 Conseptual	C2 Conceptual	C3 Conceptual	C4 Conceptual	C5 Conseptual	C6 Conseptual
	Procedural	C1 Procedural	C2 Procedural	C3 Procedural	C1 Procedural	C2 Procedural	C3 Procedural
	Metacognitive	C1 Metakognitive	C2 Metakognitive	C3 Metakognitive	C4 Metakognitive	C3 Metakognitive	C3 Metacognitive

Development Stage

After determining the purpose of this lecture, the next researcher will design the design of the instrument development developed in this study. This process is carried out by researchers by making questions that both the objectives of the lectures that have been set in the previous stage, after which a validation process is carried out by 2 experts to get input on the instrument developed. The results of this validation will be presented per cognitive domain C1 – C6 with the knowledge dimensions of the revised Bloom's Taxonomy. An explanation of the development in the C1 domain can be seen in Table 3.

Table 3. Development of Instruments in the C1 Realm (Memorization)

Dimensi	Verb	Initial Item Formulation	Expert Advice	Edited Item Formulation
Factual	List	Mention 3 benefits of using radioactivity based on their nature and effects on human life.	The list is more appropriate when using verbs.	List 3 kinds of radioactive applications based on their characteristics.
Conceptual	Explain	Explain the spectrum of toxic effects caused by chemicals in the human body	The meaning of the spectrum is not clear and too broad	Explain the impacts and risks of hazardous materials (B3) to the human health.
Procedural	How is	Tabulate State and explain the classification of water according to its designation	It is better to provide data on water sample parameters and then classify them based on water quality standards	The following is the water content data: TSS C1 = 100, Lx = 50 DO C1 = 2, Lx = 6 pH C1 = 8, Lx = 6-9 Fecal coliform C1 = 2000, Lx = 1000 BOD C1 = 8, Lx = 2 Se C1 = 0.07, Lx = 0.01 How is the water quality based on the data above?
Meta Metacognitive	Appropria te Use	Why does water contcontamh the organic matter has a high BOD number?	(Because this is the remember stage so that the use of data will be more appropriate when conducting an analysis or study.)	The results of the analysis of the COD and BOD values of well water show the following data. Sample Code A111, Sample volume = 2ml, COD = 40mg/L Sample Code A112, Sample volume = 2ml, COD = 80 mg/L Sample Code A111, Sample volume = 250mg/L, BOD = 12.8mg/L Sample Code A112, Sample volume = 250 mg/L, BOD = 19.2 mg/L What can be explained by the results of the sample analysis above

Remembering is the process of recalling material, facts, or basic concepts that have been learned. Appropriate verbs for test items such as identify, list, define, remember, repeat memorize. Remembering also recognizes or recalls knowledge from memory. In remembering, memory is used to generate or retrieve

definitions, facts, or lists or to read previously learned information (Bloom et al., 1956; Krathwohl, 2002). In the first point, it can be seen that the verb "list" is more appropriate than "to mention", while in the second point, the verb "to explain" is more appropriate. On the third and fourth items, the experts said that additional data was needed. A further note is that the item on recall is not only about definitions, but also about definition comparisons. Furthermore, to explain the procedural dimension, the use of the word "tabulate" is intended to arrange components in a group or make a classification, but this is considered inaccurate and it is recommended to use a verb that can provide an answer such as "how is".

In simple terms metacognition is defined as "rethinking what has been thought", there are even experts who link metacognition with the control function or information processing. Although the definitions are different, in general metacognition is a person's awareness or knowledge of the processes and results of his thinking (cognition) and his ability to control and evaluate these cognitive processes. This is as shown in the following question item which asks students to evaluate and rethink a problem based on the data from the water quality analysis by considering the COD and BOD values shown in the question items.

The next discussion regarding the development carried out in the realm of C2 (understanding) will also be presented on how the results of input from experts and also other explanations regarding the development carried out in this study will be presented. Table 4 will show the development carried out in the realm of C2 (understanding).

Table 4. Instrument Development in the C2 Realm (Understanding)

Dimensi	Verb	Initial Item Formulation	Expert Advice	Edited Item Formulation
Factual	Draw conclusion	If the water source contains a sufficiently high suspended residue (600mg/L), what can be concluded from this statement?	Correct the sentence structure	A body of water contains suspended solids at a concentration of 600 mg/L. Conclude water quality based on these data.
Conceptual	Interpret	How does global climate change affect the increase of the earth's surface temperature	Correct the sentence structure	How does an increase in the earth's surface temperature affect global climate change
Procedural	Predict	What is the effect of using detergent as household waste that is dumped into a river	Choose a more appropriate word to predict what damage will be caused	What are the likely impacts of dumping detergent as household waste into a river
Metacognitive	Execute	After you learn the concept of water pollution, classify the water pollutants that occur in lakes, rivers, and seas.	The content and context of the question must be clear. In metacognition, in addition to thinking about a design, for example, then rethink the work of the proposed design	How do you develop a model of water pollution and its mitigation?

Table 4 shows that the level of understanding is explaining an idea or concept. The appropriate verbs for the test items are identified, discuss, describe, review, conclude, illustrate, interpret. Krathwohl (2002) taxonomy stated that understanding means constructing meaning from various types of functions or activities such as giving examples, classifying, summarizing, inferring, comparing, or explaining. The first and second points have been deemed appropriate by experts, while the third item needs to be reformulated and the fourth item must explain the context of the question. In the latter, apart from thinking about a design, it should be about how to explain the work of the proposed design. Knowlton et al. (2022), described remembering in which automatic processes lead to encoding of valuable information and rely on metacognitive awareness of effective deep encoding strategies. The next explanation regarding development in the C3 realm (applying) can be seen in Table 5.

Table 5. Development of Instruments in the C3 Area (Applying)

Dimensions	Verb	Initial Question Points	Expert advice	Repair Question Points
Factual	Classify	Classify the sources and functions of the following nutrients for plant growth: Phosphorus (P), Potassium (K), Magnesium (Mg), copper (Cu), Manganese, iron (Fe), sodium, zinc (Zn), oxygen.	Choose the right words, concise and easy to understand	Group the following nutrient elements based on the source and function. Phosphorus (P), Potassium (K), Magnesium (Mg), Copper (Cu), Manganese (Mn), Iron (Fe), Sodium (Na), Zinc (Zn), Nitrogen(N)
Conceptual	Describe	Name 4 parameters to measure the characteristics of rainwater and explain how to measure them.	Create a simpler sentence even to determine the application of a concept.	Describe methods of measuring water quality parameters of rainwater
Procedural	Calculate	Make an experimental design to measure the LD50 of an experiment.	You should provide the data in the form of charts/plots on concentrating total population species, from the graph students are asked to determine the LD50	Calculate the LD50 based on the following data. Wax virus =100 Animal/group = 10 Dead animals = 10 Live animal = 0 Pi = 1 II. Wax virus =10-1 Animal/group = 10 Dead animals = 10 Live animal = 0 Pi = 1 III. Wax virus =10-2 Animal/group = 10 Dead animals = 10 Live animal = 0 Pi = 1
Metacognition	Construct	PLTN is the kind of power plant that can generate considerable energy, but why there are several countries including Indonesia have not yet decided whether to set up a nuclear power plant or not to meet their needs for electrical energy progressively increasing?	Sentence questions already well-lived mashed	Why are some countries including Indonesia have not decided to set up and use the PLTN?

Then for the next cognitive domain at C4 (analysis), C5 (evaluation), and C6 (making) it can be seen in Tables 6, 7, and 8, respectively, which explains the development in each domain carried out by the researcher.

Table 6. Instrument Development in the C4 Realm (Analyze)

Dimensions	Verb	Initial Question Points	Expert advice	Repair Question Points
Factual	Order	Explain how the degradation of land in Indonesia in general	Correct the sentence	Explain how the process of land degradation
Conceptual	Explain	What caused the salinity in the soil?	Note the verb	Explain the factors contributing to the increase of salinity in the soil
Procedural	Differentiate	How is the reaction mechanism of CO gas that can be deadly to humans?	Because the required ability to "differentiate" made an improper question.	SO2 and NOx gas can be a cause of acid rain What is the mechanism of the two compounds that are harmful to human life.

Dimensions	Verb	Initial Question Points	Expert advice	Repair Question Points
Metacognition	Achieve	Fix students select one of the readings given http://www.geocities.ws/athens/academy/1943/paper/p0605.pdf Global warming countermeasures in the Energy User Sector http://ithamasithah25.files.wordpress.com/2013/05/jurnal-menipisnya-lapisan-ozon-pengkomp-e1a012016.pdf http://jurnal.lapan.go.id/index.php/berita_dirgantara/article/viewFile/734/65, The urgency of keeping the ozone layer for the inhabitants of the earth. Then make a review of the reading.	Make sure the selection of readings given context a balanced review of what's required to be made of students?	Students select one of the readings given http://www.geocities.ws/athens/academy/1943/paper/p0605.pdf, Global warming countermeasures in the Energy User Sector http://ithamasithah25.files.wordpress.com/2013/05/jurnal-menipisnya-lapisan-ozon-pengkomp-e1a012016.pdf http://jurnal.lapan.go.id/index.php/berita_dirgantara/article/viewFile/734/65, The urgency of keeping the ozone layer for the inhabitants of the earth. Then make a review of the reading.

Table 7. Instrument Development in the C5 Area (Evaluating)

Dimensions	Verb	Initial Question Points	Expert advice	Repair Question Points
Factual	rank	Analysis of well water thre e regions A, B and C get the results as shown in https://sl.ut.ac.id/Analysis_of_waters Explain the condition of well waterr for areas A, B and C. In addition, also explain how many limits are allowed / suitable for use as drinking water from each parameter by the Decree of the Minister of Health of the Republic of Indonesia	It should be added that water quality standards are used for comparison.	Same problem
Conceptual	assess	How is the depletion of the ozone layer related to global warming and climate change	Depletion of the ozone layer change with increased concentrations of greenhouse gases in the atmosphere	How is the relationship between the depletion of the ozone layer with an increased concentration of greenhouse gases in the atmosphere
Procedural	conclude	Mining of metal taken from the earth when used properly can provide benefit to mankind but can also be dangerous when human impacts are not able to control themselves in wielding it. If the tailings, which is the residue that comes from the rest of the processing or extraction of the main elements, are not repaired, they will leave hazardous waste. Explain the benefits and harms obtained through metal mining activities. Furthermore, what is your opinion about the environmental damage caused by gold mining activities and how to improve the impact of soil damage due to mining activities? See Articles on Review of Ex-Mining Land Reclamation and Aspects of Mineral Conservation in Sabtanto Joko Suprapto	The context should be focused on gold mining and the pollution it causes	Explain the benefits and harms obtained through gold metal mining activities. Furthermore, what do you think about the environmental damage caused by gold mining activities?

Dimensions	Verb	Initial Question Points	Expert advice	Repair Question Points
		(2008)https://www.scribd.com/document/33483281/Tanto- Paper-Reclamation-Used-Land -		
Metacognition	Action	What steps can we take to reduce or improve land caused by the impact of tin mining?	Correct the sentence	What steps can we take to reduce the decline in soil quality due to tin mining activities

Table 8. Instrument Development in the C6 Realm (Making)

Dimensions	Verb	Initial Question Points	Expert advice	Repair Question Points
Factual	Combine	Try to do a safe way to avoid dust contamination from factory exhaust for the local community	Correct the sentence	How to handle particulate matter pollution generated from factory or motor vehicle exhaust
Conceptual	Plan	What efforts can be suggested/planned to reduce pollution of river water contaminated with industrial waste/effluent?	Correct the sentence	What efforts can be planned to reduce the decline in river water quality due to contamination by industrial waste
Procedural	Compose	Design a river water purification activity that can be used by the surrounding community for bathing and washing needs	Correct the sentence	Design a method of water purification/purification that can be adapted and utilized by the community
Metacognition	Actualize	With a chemical-based environment, what can be done to run sustainable development, so that we become healthy, and safe from disasters	Unclear questions should be replaced	With a chemical-based environment, what can be done to run sustainable development, so that we become healthy, and safe from disasters

Dissemination Stage

This stage is carried out through trials carried out on students who take environmental chemistry courses as many as 20 students. Based on the test results, it was found that 30.15% stated that the questions given were relatively easy, 44.80% moderate and 25.05% difficult. This is further explained as follows. Items given at the memory level tend to be easily categorized by students on the fact dimension (100%) and tend to decrease in the concept dimension (65%), procedure dimension (47.36%), and meta-analysis dimension (10%) as shown in Figure 1.

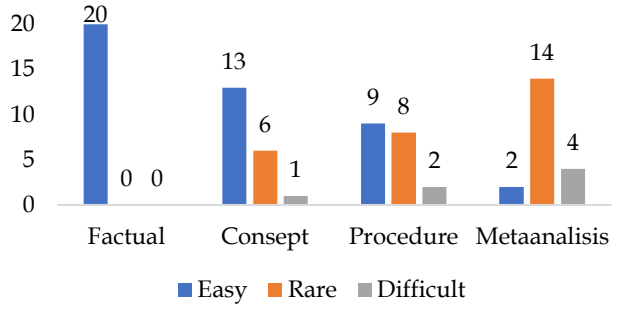

Figure 1. Distribution of difficulty levels in the c1 region (remembering)

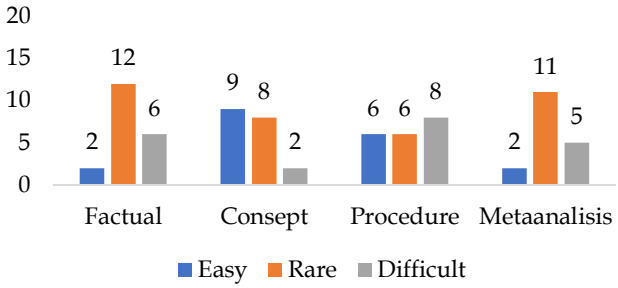

Figure 2. Distribution of difficulty levels in the c2 realm (understanding)

Some respond easily, but some respond and some even respond with difficulty. Students who answered moderately on the factual dimension were 60% of the students, the conceptual dimension was 42.10%, the procedural dimension was 30% and the meta-analysis dimension was 61.11%. Thus, it can be explained that the items at the level of understanding students can still work on the questions even though they require deeper thinking than just remembering. The questions given in the realm of application of student responses vary as shown in Figure 3. Students tend to respond in the high-medium category, namely for items on the fact dimension by 65%, on the concept dimension by 52.63%, for items on the meta dimension. -analysis 75%.

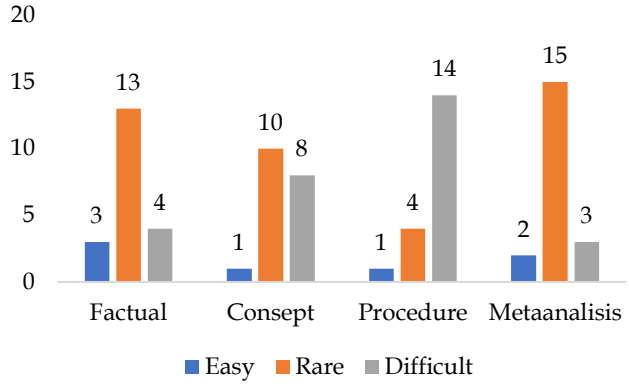

Figure 3. Distribution of difficulty levels in the c3 realm (applying)

Based on Figure 3, it was found that 73.68% of students categorize difficult items on the procedural dimension. Thus, it can be explained that the items at the level of applying students can still work on the questions even though students still have difficulty working on the questions on the procedural dimension. Next Figure 4 will show how the level of difficulty is based on student responses in the realm of analysis.

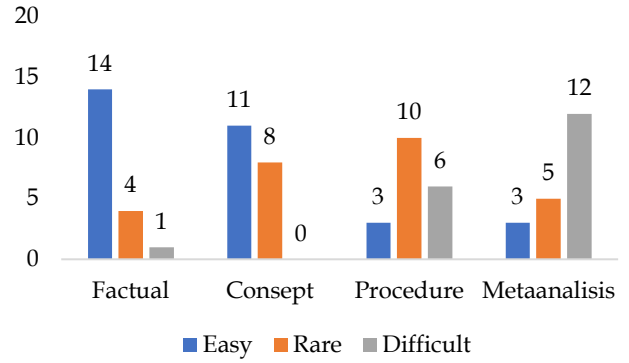

Figure 4. Distribution of difficulty levels in area C4 (analyzing)

Figure 4 shows that the items given at the analysis level tend to be easily responded to by students on the factual dimension (73.68%), and the concept dimension (57.89%). Furthermore, many students answered moderately on the procedure dimension (52.63%) and tended to have difficulty responding to the meta-analysis dimension (60%). Through these data, it can be explained that at the level of analytical thinking for factual and conceptual dimensions, students are still able to do it. However, on the dimensions of the procedure and meta-analysis, students began to experience difficulties in solving them. According to Oguz, A. A. *et.al.* (2011), measurement of metacognition is naturally difficult. Metacognition isn't a behavior. It's not just an internal process. On the contrary, people aren't aware of their own processes.

Furthermore, Figure 5 will show the distribution of difficulty levels in the C5 range.

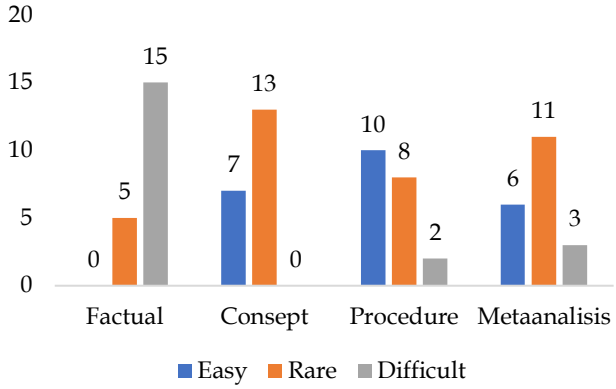

Figure 5. Distribution of Difficulty Levels in Area C5 (evaluating)

Based on Figure 4, the questions given at the evaluation level tend to vary based on student responses. Most respondents find it difficult to categorize items with factual dimension analysis on questions (75%), most respondents categorize easily on meta-analysis dimensions (55%), and most respondents categorize moderate on procedure dimensions (50%). Then the distribution of the level of difficulty in the C6 domain can be seen in Figure 6.

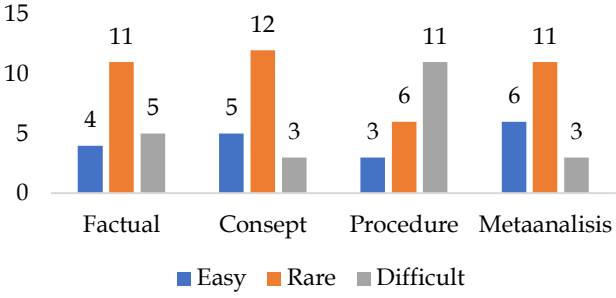

Figure 6. Distribution of difficulty levels in the c6 realm (make)

In Figure 6, the questions given at the creative level tend to be responded to by students. In this realm, 55% of students responded to the fact dimension, then 60% to the concept dimension, and 55% to the meta-analysis dimension. Although most of the questions at the creative level were answered moderately by students, quite a several students answered difficult for the procedural dimension (55%).

The results of the study indicate that several provisions need to be considered in making an item, including the preparation of sentences that are easy to

understand, choosing the right verbs to achieve the expected competencies. Several things need to be considered in compiling items, including clearly compiling statements of situations and problems, tests must be designed to measure performance objectively (Stankov et al., 2008; Rahbarnia et al., 2014; Sivaraman & Krishna, 2015).

The concept of higher-order thinking in Bloom's Taxonomy, among others, is indicated by the ability to reason and think critically. One of the higher-order thinking skills is shown through critical thinking skills. Learning that consistently applies students' critical thinking skills makes students competent in managing their learning process (Dwyer et al., 2014; Larsson, 2017; Oktaviana et al., 2020). The National Research Council (Buckingham Shum & Deakin Crick, 2016) explains that cognitive skills such as the ability to think critically, solve problems and work in teams are competencies that need to be achieved by students. Furthermore, students are expected to be creative and updated, and skilled in using information technology. Through critical thinking skills, students can solve problems and make decisions, and in the end, can carry out metacognition from their learning (Larsson, 2017). These skills can be trained through giving assignments to students, for example in the form of tests or practice questions. Through practice, it is expected to improve or improve the way of thinking which includes the development of creativity and innovation.

Conclusion

The four types of knowledge in Bloom's remembering, understanding, and applying levels discussed in this paper are factual, conceptual, procedural, and metacognitive knowledge. Factual knowledge asks student teachers to organize things or communicate understanding systematically. Conceptual knowledge asks student teachers to explain categories or classifications and their relationships. Procedural knowledge asks student teachers to describe a series of jobs or steps in a logical and systematic way. Metacognitive knowledge asks student teachers to go through the process of thinking about their own understanding of knowledge. The results showed that several aspects must be considered in making a good item, including formulating sentences that are easy to understand and the correct choice of verbs to measure the expected level of competence. Overall, items in the factual and conceptual dimensions tend to be considered easy or moderate in difficulty. In contrast, those in procedural and metacognitive dimensions tend to be considered moderate and difficult.

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The three of us as authors of this article worked from preparing research proposals to writing reports and journal articles. Meanwhile, the researchers collaborated with chemistry lecturers from other universities in developing the questions assisted by developers.

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There is no conflict of interest.

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