

Teacher Difficulties for Develop Higher Order Thinking Skills Assessment Instrument on Reaction Rate

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ARTICLE INFO

Article history:

Received November 03, 2021

Revised November 05, 2021

Accepted March 20, 2022

Available online April 25, 2022

Kata Kunci:

HOTS, Instrumen, Laju Reaksi

Keywords:

HOTS, Instrument, Reaction Rate



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ABSTRAK

Penggunaan instrumen penilaian kemampuan berpikir tingkat tinggi diharapkan mampu mengembangkan kemampuan peserta didik untuk memecahkan masalah nyata serta memberikan peserta didik kesempatan agar mampu memikirkan, menerapkan dan berkolaborasi dengan sistematis melalui proses atau hasil yang sesuai dengan persyaratan kelulusan. Tujuan penelitian ini ialah menganalisis proses pembelajaran kimia, menjelaskan instrumen penilaian yang digunakan dalam proses pembelajaran kimia dan untuk mengetahui permasalahan yang dihadapi guru dalam melaksanakan penilaian kemampuan berpikir tingkat tinggi. Jenis penelitian yang digunakan adalah evaluasi deskriptif. Subjek evaluasi ini adalah guru kimia. Instrumen yang digunakan dalam penelitian ini adalah lembar angket pertanyaan terbuka yang menggali tentang penerapan dan pemahaman guru mengenai instrumen penilaian HOTS. Data dianalisis secara deskriptif. Hasil penelitian menunjukkan bahwa hanya 40% guru di sekolah telah melakukan pengukuran kemampuan berpikir tingkat tinggi dikarenakan kurangnya pemahaman guru mengenai kemampuan berpikir tingkat tinggi, waktu pembuatan soal yang lama dan jumlah peserta didik yang banyak, sehingga perlu diadakan pengembang instrumen penilaian HOTS pada materi laju reaksi.

ABSTRACT

The use of high-ability assessment instruments is expected to develop students' abilities to solve real problems and provide opportunities for students to apply, implement and systematically through processes or results by graduation requirements. The purpose of this study was to analyze the chemistry learning process, explain the instruments used in the learning process, and find out the problems teachers face in assessing higher-order thinking skills. The type of research used is descriptive evaluation. The subject of this evaluation is a chemistry teacher. The instrument used in this study was an open-ended question questionnaire about the teacher's application and understanding of the HOTS assessment instrument. Data were analyzed descriptively. The results showed that only 40% of teachers in schools had measured higher-order thinking skills due to a lack of understanding of higher-order thinking skills, so it was necessary to develop a HOTS assessment instrument for reaction materials.

1. INTRODUCTION

Due to the complexity of life in the 21st century, it requires people with qualified abilities to be able to survive. Superior human resources (HR) were needed in facing the extraordinary progress of the 21st century that the National Education Association has identified 21st century skills as "The 4Cs", which includes critical thinking, creativity, communication, and collaboration abilities (Afandi et al., 2019; Bedir, 2019; Changwong et al., 2018). "The 4Cs" are also called higher order thinking skills (HOTS) which are required from students, such as critical thinking skills and creative thinking (Ardiansyah, 2018; Nurmala & Mucti, 2019; Putranta & Supahar, 2019). Students are not only asked to apply what they have learned but also to analyse and evaluate what they have acquired to be able to solve problems and make decisions in everyday life (Ma'ulah & Juniati, 2019; Pratama & Retnawati, 2018). Students should possess these

skills to face the challenges of the 21st century. To sharpen these skills, students can reform the learning process by implementing HOTS based evaluation questions (Gunada et al., 2021; Yulianto et al., 2021).

The results of the national exam (UN) on the senior high school (SMA) reported by the Education Assessment Center of The Education And Culture Ministry have recorded the results of the National Examination for chemistry subjects which showed a fluctuating trend (Kemendikbud, 2019a). This can be seen from the data provided by Puspendik in 2017 the national average for chemistry examinations was 53.83% (Kemendikbud, 2019b). In 2018, the average reached 51.13%. Meanwhile, in 2019 it reached an average of 50.99%. This data on average national examinations for chemistry is a clear indication of instability. The year 2018 has decreased and then decreased in 2019. This percentage has decreased when compared to the percentage in 2015 which was 60.49% (Kemendikbud, 2019a). This shows that the quality of Indonesian education still needs attention. The cause of the decline in students' national exam scores included the use of the Higher Order Thinking Skills questions that had been started since 2016 (Kemendikbud, 2019a).

Learning experiences that are not limited so that ideas and emotions are intertwined with classroom situations are good learning (Ferri et al., 2020; Santagata & Yeh, 2014; Yan et al., 2021). Chemistry lessons are considered by most of the students as abstract material (Dumitrescu et al., 2014; Fan et al., 2015). At the basic level, chemistry is a subject that seems more difficult than other fields. Chemistry is studied not only limited to solving numbers but there must be a simplification of objects in teaching it such as an explanation of chemical phenomena or problems that exist in everyday life (Achuthan et al., 2018; Awan et al., 2011; Su & Cheng, 2019). Explaining chemical phenomena or problems in everyday life is the main goal of studying chemistry (Cagatay & Demircioglu, 2013). Process skills and understanding of students' concepts can increase and meet graduation standards if in the chemistry learning process students are actively involved (Chairam et al., 2015; Mutlu, 2020). The ability of students to apply chemical concepts that they already have can be known through ability measurement.

These thinking skills are divided into low level and high level thinking skills, both of which are part of the cognitive domain (Fuad et al., 2017; Popandopulo et al., 2021; Putranta & Supahar, 2019). In 1956, Bloom introduced an outline that became the basic concept of thinking skills, hence the name Bloom's taxonomy (Effendi, 2017; Juhanda, 2016). The hierarchical order that defines skills from low to high is called Bloom's taxonomy (Darmawan & Sujoko, 2013; Netriwati, 2018). Bloom's taxonomy has been improved by Bloom's students in 1994 named Lorin Anderson and Krathwohl, psychologists who are cognitivism in order to keep up with the times. These changes only occur in the cognitive domain. The results were published in 2001, each level in the taxonomy undergoes changes, namely changing the form from nouns to verbs. In addition, several stages underwent changes, such as evaluation which was previously at level C6 in the old Bloom taxonomy, down to evaluating at level C5 in the revised Bloom taxonomy. Meanwhile, the synthesis at the C5 level rose to the C6 position of the revised Bloom's taxonomy with a fundamental change, namely creating (Arievitch, 2020; Nursa'adah et al., 2016). Students at high-level thinking apply newly acquired knowledge or information and manipulate the information they have to get new answers in solving problems (Istiyono et al., 2018; Tanti et al., 2020; Tanudjaya & Doorman, 2020). Higher order thinking skills focus on developing students' ability to analyze effectively, evaluate by drawing conclusions from existing information, and create (synthesize) something new (Ardiansyah, 2018; Chinedu & Kamin, 2015). Higher order thinking skills have been considered as the highest level in human cognitive processes (Anwar et al., 2020; Fanani, 2018). Measurement of higher-order thinking skills is important to determine the extent to which students can apply chemistry concepts that they have learned.

The previous research stated that in chemistry, it can be completed by first determining the achievement indicators of students (Bortnik et al., 2017; Lai & Hwang, 2014; Suardana et al., 2018). However, other results of research stated that there were many evaluation processes in various schools that were not suitable with the principles of good assessment compilation, such as non-biased and standardized criteria (Evrero, 2015; Sanusi, 2020; Widiana & Rendra, 2020). Higher order thinking is only done in a few chemistry topics, especially acid base solutions. Thus, an assessment of the HOTS questions about reaction rates needs to be done as one of the solution to improve Indonesian nation at the international level, especially the results of the Program for International Student Assessment (PISA). Therefore, we need a qualified indicator that can assist teachers in assessing the process and the outcome. Quality instruments must meet certain rules that are tailored to their function. The development of instruments that can measure the achievement of learning objectives affects the progress of the learning process. One of them is through the development of HOTS based instruments. The purpose of this study was to analyze the teacher's opinion about the development of a HOTS instrument on the reaction rate material.

2. METHODS

This research was a descriptive evaluative study with a qualitative approach through needs analysis. A needs analysis was carried out by using an open questionnaire analysis. Analysis of the needs questionnaire began by giving an open questionnaire to chemistry teachers in Yogyakarta, Indonesia. The subjects in this study consisted of 10 high school chemistry teachers from Yogyakarta. Teachers were mixed about their level of experience. Half of them (5 out of 10) had more than 15 years of experience but others had less than ten years of teaching experience. Before filling in the open questionnaire each teacher was informed about the research objectives and asked for permission to participate and permission to collect data. Teachers were assured that their names and details would not be mentioned in the publications. The subject in this research shown in [Table 1](#).

Table 1. The Subject in this Research

Name	A	B	C	D	E	F	G	H	I	J
Experience	16	20	7 Year	5 Year	18	20	2 Year	8 Year	15	8 Year
Teaching	Year	Year			Year	Year			Year	

The instrument used was a needs analysis questionnaire consisting of 6 open questions. Data were collected utilizing an open questionnaire that was given online to all teachers. The open questionnaire was intended to find out the teacher's perspective, problems during the manufacture and application of the HOTS assessment instrument on chemistry, and in particular the reaction rate. Data from open questionnaire items were analyzed using qualitative descriptive analysis. Validation questionnaire by 5 education experts, the aspects assessed are: (1) language, (2) construction and (3) the suitability of the questions with indicators. The technique used to analyze the data is descriptive qualitative and quantitative analysis.

3. RESULTS AND DISCUSSION

Results

The analysis is carried out for teachers who have implemented a learning process that trains students' higher order thinking skills. However, it is still limited to a few chemical materials. The results of the descriptive analysis of the open questionnaire given to chemistry teachers who have used assessment instruments to measure higher-order thinking skills in the reaction rate material. Based on analysis data, it is illustrated that there are still many teachers who have not used higher-order thinking skills assessment instruments on reaction rate material, such as 60% and 40% of teachers have used higher order thinking skills assessment instruments on reaction rate material. This phenomenon occurred because the teacher's lack of understanding and time regarding higher order thinking skills and the applied learning process has not trained students' higher order thinking skills. In the material on reaction rate, students were provided with sufficient information from the teacher, so that students were less active in the learning process. This results in learning in the form of memorizing concepts so that students find it difficult to solve complex problems during the learning process. Besides, some teachers have used higher order thinking skills assessment instruments, students are asked to solve problems by linking the learning concept to a real-life theory. Cognitive dimensions of higher order thinking are presented in [Table 2](#).

Table 2. Cognitive Dimensions of Higher Order Thinking Skills

Cognitive Dimension	Indicator	Description
Analyze (C4)	Differentiate	a. The ability to distinguish the parts of the whole structure in an appropriate form,
		b. Discriminating relevant, important, and unimportant information, then paying attention to relevant and important information,
		c. Organizes structurally and determines how the parts fit into the structure of the whole.
Analyze (C4)	Organize	a. Identifying elements together into an interrelated structure,
		b. Build systematic and related relationships between pieces of information,

Cognitive Dimension	Indicator	Description
Evaluate (C5)	Attribute	c. Can be done in conjunction with differentiating activities, namely first identifying relevant or important elements and then determining a structure formed from those elements.
		a. Mention the point of view, bias, value, or purpose of a proposed problem
		b. Using more basic knowledge in order to be able to draw conclusions or the intent of the core problem posed
	Verify	c. Determine the purpose of a problem given by the teacher or question maker.
		Ability to test for internal consistency or errors in operations or results.
Critique	a. Judging results or operations based on certain criteria and standards	
	b. Detect the effectiveness and efficiency of the methods or procedures used to solve problems	
Create (C6)	Formulate	c. Note the positive and negative characteristics of a product and make a decision.
		Involves the process of describing the problem and making choices/alternatives that meet certain criteria.
	Plan	a. Planning a method of solving a problem that is in accordance with the criteria for the problem
		b. Practicing steps to create a real solution to a problem
Produce	c. Determine sub-objectives or break down tasks into sub-tasks that must be done when solving problems.	
	a. Creating a product or something that meets a certain description or criteria	
		b. The process of implementing a plan to solve a problem that meets certain specifications.

Based on the discussion previously disclosed, it can be concluded that higher order thinking skills are thinking skills that involve the process of analyzing, evaluating, and creating which are contained in the top three domains of Bloom's taxonomy with dimensions of conceptual, procedural, and metacognitive knowledge. In the cognitive dimension of analyzing (C4) the indicators used in this study are distinguishing, organizing, and attributing, for the cognitive evaluating machine (C5) that is examining and criticizing, while in the cognitive dimension of creating (C6), namely formulating, planning and producing.

The results of the study show that many teachers use traditional assessment instruments to assess student learning outcomes, basically the test questions are given after students learn the topic of reaction rates. Examples of instruments commonly used by teachers in assessing learning outcomes are: 1) Chemical reactions based on collision reactions, 2) the effect of temperature on the collisions frequency, 3) the effect of surface area on the collisions frequency, and 4) the effect of concentration on the collisions frequency. Based on data analysis, the test questions were given by the school teachers was to evaluate the topic in the form of multiple choice and descriptions questions. The teacher provided examples of questions from textbooks or student worksheets such as understanding/ calculation questions. There were applications but it is rare where the teacher gave problems related to the application of reaction rate in every day life. The results of problems faced by teachers in assessing higher-order thinking skills study state that the main problems in developing an assessment of higher-order think-ing skills in [Table 3](#).

Table 3. The Problems in Developing Higher-Order Thinking Skills Assessment Instruments

Questions	Answers	Total	%
Has your school assessed higher-order thinking skills (HOTS) on the reaction rate?	Yes	4	40%
	No	6	60%
Do you have any difficulty in assessing students by assessing higher-order thinking skills (HOTS) on the reaction rate? If yes, what are some of your difficulties?	Yes	8	80%
	No	2	20%
Do you have any difficulty making an instrument for assessing higher-	Yes	9	90%

Questions	Answers	Total	%
order thinking skills (HOTS) on the reaction rate? If yes, what are your difficulties?			
Do you have any difficulty while applying higher-order thinking skills (HOTS) of the reaction rate? If yes, what are some of your difficulties?	Yes	9	90%
How do you understand the higher-order thinking skills (HOTS) assessment?	No	1	10%
How long did you spend on making the higher-order thinking skills (HOTS) assessment instrument?	\Train students' logic, mindset and creativity, at levels C4, C5 and C6.		
	2 hours to more than one week		

Based on Table 3, the teacher has not been effective in evaluating HOTS, this is due to several factors, and some teachers (8/10) said that they had difficulty in assessing students by HOTS on rate reaction "the literacy skills of students have to honed and giving a score for answer sequences". (9/10) the teacher stated that they had difficulty making an instrument for assessing HOTS on the reaction rate "missed questions when tested, lack of material, and hard to link several concepts into one question". (9/10) the teacher stated that he had difficulty in applying the assessment of HOTS on the reaction rate "unsatisfactory results because only 20% of students completed, each student's ability was different and implementing the hot assessment must be supported by a hot learning process as well". Also, the limited examples of instruments based on HOTS, especially in chemistry learning, make teachers unwilling to make instruments. The difficulty for the teacher was the indicators in the assessment, demand much time to sort out these aspects and something was confusing about the higher order thinking skills assessment questions, the teacher just understands that the question of assessing high level thinking skills was only about to analyse (C4), evaluation (C5), and creating (C6).

Discussion

Principles of arranging instruments to measure higher-order thinking skills are using a stimulus, using a new context and distinguishing levels of difficulty and complexity of thought processes (Afrita & Darussyamsu, 2020; Hamidah & Wulandari, 2021; Singh et al., 2018). The difficulty level and thought process were two different things. The test that measure memory can be easy and difficult, same with questions to measure higher-order thinking can be easy and difficult, depending on the complexity of the question or task. The Process of Making Questions and Scoring is one of the competencies that the teacher needs to have was the ability to arrange questions as a test instrument for students properly and to analyse the test results (Apling et al., 2019; Hamidah & Wulandari, 2021). The concept of complete learning which takes longer also requires teachers to understand the abilities of their students individually. Teachers did not fully understand the concept of authentic and continuous assessment. The assessment techniques that have been carried out so far have not varied as demanded by the 2013 curriculum. If allowed to continue, the above problems will get bigger and have the potential to hinder the implementation of the 2013 curriculum in schools

Teachers have difficulty with the HOTS based assessment concept used in the 2013 curriculum. Teachers were less skilled in developing process and learning outcome assessment instruments so that the assessment that has been carried out so far is still less effective (Ndiung & Jediut, 2020; Umami et al., 2021). Also, the preparation of HOTS questions by the teacher was not optimal due to time constraints and the teacher's lack of ability to make quality questions. The conditions made students passive and just sit quietly to receive the content delivered by the teacher (Afriyanti et al., 2021; Anwar et al., 2020; Suratmi et al., 2020). Besides that, another impact was to make the students' ability to do questions limited to easy and medium category questions. So that students were less responsive in solving problems. A special problem for teachers is the need for skills in developing an assessment system for learning processes and outcomes (Apling et al., 2019; Hamidah & Wulandari, 2021)(Indah, 2020). The teacher has not yet understood the higher order thinking ability assessment system so that the teacher finds it difficult to determine and develop an assessment instrument (Widyaningsih et al., 2020). Therefore it is necessary to do an example of an assessment instrument of the process and student learning outcomes fit in the demands of the 2013 Curriculum.

The higher order thinking skills require a person to apply new information or knowledge they have acquired and manipulate information to get possible answers in new situations (Gunada et al., 2021; Putranta & Supahar, 2019). Higher order thinking skills focus on developing students' ability to analyse effectively, evaluate by concluding existing information, and create (synthesize) something new (Haniah et al., 2020; Sari et al., 2020). Higher order thinking skills have been considered the highest level in human cognitive processes. Higher order thinking skills involve the ability to analyse, evaluate, and create

(Ardiansyah, 2018; Khan & Masood, 2015). The difficulties experienced by students in solving HOTS questions need to be a matter of further attention. Because the disadvantages if this is allowed to be ignored are the lagging position of Indonesian education in the world of international education and the weak human resources resulting from lagging education and the benefits that were obtained if this was studied more deeply is the practical role of teachers as educators to improve the quality of education Indonesia and its human resources. Several efforts to improve higher-order thinking skills include involving students problem solving activities irregularly; facilitating students to develop the ability to analyse and evaluate (critical thinking) and the ability to create (creative thinking); and encourage students to build their own knowledge so that learning becomes meaningful for students (Apino & Retnawati, 2017). Teachers should be aware that higher-order thinking skills would be reached when a more constructivist view was emphasized over the traditional view (information transfer), thus providing students with a meaningful active learning process.

4. CONCLUSION

The 2013 curriculum has been implemented by the teacher in schools. However, there are still many teachers in schools who still use traditional assessment in the chemistry learning process. This is because the teachers still do not understand the assessment of higher order thinking skills. Furthermore, the making of higher order thinking skills assessment instruments takes a long time and there is a lack of examples in making higher.

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