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The cognitive alignment of mathematics teachers' assessments and its curriculum

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ABSTRACT

This study aims to explore how the cognitive level alignment between the teachers' assessments and Mathematics curriculum in Indonesia related to students' higher order thinking skills (HOTS) development. The study adopted a descriptive exploratory design with a qualitative approach. The participants of this study were 15 high school mathematics teachers from Malang City and the Nganjuk district. Data were collected from the results of the assessments and indicators of the mathematics curriculum used by teachers. The data collected were analyzed using Anderson & Krathwohl's Taxonomy to determine the alignment of the cognitive level from assessments and curriculum. In the semi-structured interview session, we recorded teachers' responses who were able to construct HOTS-based assessments. Our findings showed: i) mathematics indicators primarily targeted students' thinking skills at the low cognitive level, namely applying; ii) teachers' assessments were more dominant at the low cognitive level, and there was no assessment at create level; and iii) the alignment of the cognitive level was relatively low for the HOTS category. The study findings can be used to improve curriculum and assessment in education. They can also be used as reflections for Mathematics teachers on the importance of aligning the cognitive level, especially that develop students' HOTS.

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1. INTRODUCTION

In the 21st century, the world is intensively implementing the industrial revolution 4.0 and society 5.0; therefore, students are required to develop their thinking skills. "Good thinking" such as students' critical and creative thinking can be taught through various disciplines and subjects like mathematics so that students can develop their thinking skills [1]. In fact, education development requires skills that must be possessed by all students, known as 21st-century skill competencies or 4Cs, namely creativity thinking and innovation, critical thinking and problem-solving, communication, and collaboration [2], [3]. In addition, the education system must instruct 21st-century 4Cs skills from an early age to prepare students to become future generations in a globalized world that demands collaboration and innovative skills [4]. The results of previous research also showed that mastering HOTS can help students to formulate creative ideas, express opinions, make decisions, understand complex problems, solve problems, test hypotheses, and evaluate the truth of information [5]. Thus, HOTS needs to be developed in the teaching and learning process by the teacher during the learning.

higher order thinking skills (HOTS) can be developed at all age levels and in all learning subjects [6], [7]. HOTS carry many meanings in the world of education. This is supported by the statement of Sadijah *et al.* [8] that HOTS has various definitions based on several experts. HOTS is described as analyzing, evaluating, and creating skills [9]. HOTS is seen as a cognitive ability at a high level which includes analysis, synthesis, evaluation, estimation, creative thinking, decision making, systematic thinking, and critical thinking [10]. Students need to improve their thinking skills toward HOTS. This is in line with the results of research by Dolapcioglu and Doğanay [11] reporting that increasing thinking skills at a high level are very important for learning Mathematics. Through HOTS teaching, the teacher allows students to learn, connect, and contribute to continuously creating new knowledge [10]. HOTS is vital in learning Mathematics so that students can have good abilities [12] and overcome the problems of everyday life because HOTS will improve their thinking skills to face the challenges of the 21st century [13]. Abkary and Purnawarman [14] stated that HOTS is essential as a basis for students' skills and HOTS must be implemented in every subject. Therefore, the HOTS-oriented learning process is important to be applied to all subjects, including Mathematics.

HOTS plays a vital role in the world of education, so these skills must be included in the curriculum. In line with Ariyana *et al.* [15] that teaching HOTS must be conveyed implicitly or explicitly. In other words, learning HOTS must be embedded in the curriculum or taught directly by the teacher. The curriculum must contain HOTS because the curriculum is designed not only to achieve learning objectives but a curriculum that contains HOTS is intended to give students a real learning experience [16]. Another research highlighted that the curriculum and HOTS-oriented teaching includes critical thinking, creative, and problem-solving skills that are useful for preparing students’ roles in society [17]. Furthermore, one of the essential aspects and the paramount need in the mathematics curriculum is the ability to solve mathematics problems categorized as HOTS [18]. However, applying HOTS in learning is seen as difficult for both teachers and students. In addition, the process of solving Mathematics problems in schools emphasizes more on learning outcomes more than the reasoning process and students’ HOTS [19]. This is in line with previous study that teaching HOTS and learning HOTS are equally difficult, while teacher competence to be able to manage learning activities related to HOTS when transacting learning objectives from the curriculum must be ensured [20]. However, previous research has found that pre-service teachers experience mathematics anxiety which causes them to have difficulty understanding problems [21].

The learning process to improve HOTS must be implemented in curriculum planning and taught by teachers in learning mathematics in the classroom. Furthermore, teachers have a broader and more flexible role in classroom learning. The teacher plays an active role as an educator, coordinator, partner, assessor, adviser, or in other words a versatile person so the teacher is required to arrange the teaching process in such a way as to create pleasure and curiosity in students [22]. Therefore, mathematics teachers and future teachers need to be educated in the teaching of high-level skills [11]. This is supported by previous research which stated that teachers must involve students in learning and teaching to create and improve students' thinking processes [23]. This is evidenced by research highlighting that teachers must carry out teaching and assessment oriented to high-level abilities, regardless of whether these abilities are shown in the curriculum directly or not [6]. Recently, the teacher’s role has been expanding. The teacher is now a mentor and facilitator who deepens students’ knowledge and facilitates students to acquire high-level abilities apart from only transacting knowledge [24]. So, teachers need to know the right assessment to improve students’ HOTS, such as students’ problem-solving abilities [25]. Furthermore, teachers are expected to be able to develop assessments that are valid, supportive, and provide accurate information regarding what students must know and obtain according to the standard objectives designed in the curriculum [26].

Teachers must have the skills to arrange assessments of the teaching and learning process in the classroom, especially HOTS-based assessments. Teachers must be involved in the thought process when determining the learning process and compiling mathematics assessments [27]. Furthermore, teachers must have competencies that include the ability to conduct assessments, both on the learning process and student learning outcomes based on the applied curriculum [28]. In mathematics, giving assessments in the form of problem solving or multiple representation tasks can improve students’ cognitive processes where the assessments create space for reflection and analysis of the problems given [29], [30]. A study [17] highlighted that teachers can provide HOTS-based assessments in the form of i) contextual problems; ii) difficult problems; iii) problems that require many steps; and iv) relatively complex, unfamiliar questions, along with visualization.

Teachers are not only required to make HOTS-based assessments, but they must also have the ability to align the cognitive level between the assessments and the curriculum. This is supported by the statement that the assessments given by teachers to students must be in line with their cognitive level and the objectives of the curriculum [31], [32]. Research related to students’ thinking skills through learning models and various forms of HOTS-based assessment tasks has been widely carried out [11], [33]. In addition to research on HOTS-based assessments, research on the alignment between assessments and the desired outcomes of the curriculum is also important. Even, alignment is currently not widely used in classroom learning and there is a lack of studies exploring alignment [34]. Research on the Science Curriculum in Lebanon shows that the level of alignment between the assessment and the curriculum is relatively low, and the dominant assessment is made targeting the low level of understanding and knowledge [35]. In fact, the principle of designing assessment tasks is that assessment tasks must be designed to achieve the desired learning outcomes [36].

Assessment is defined as a practice of collecting, studying, and using information related to student learning outcomes in a systematic, comprehensive, and consistent manner to improve student learning and development [37]. Teacher teaching and assessment activities mainly focus on low cognitive levels induced by teacher knowledge and lack of understanding of the alignment between curriculum, teaching, and assessment practices in the Netherlands [38]. Therefore, research related to the alignment between the desired outcomes of the curriculum and assessments made by teachers is still necessary and essential.

Previous studies stated that the alignment between curriculum and assessment is vital. Troia *et al.* [39] investigated content alignment and cognitive level of assessment with state standards. Zheng *et al.* [40] conducted supporting research in 2020 which evaluated the alignment between learning designs and curriculum outcomes. Another study [41] also researched the use of Bloom’s taxonomy as a tool to align the skills referred to in the Biological Sciences Curriculum with related assessments. Muhayimana *et al.* [42] examined the use of Bloom’s taxonomy to assess cognitive level alignment between questions on English exams and the curriculum in Rwandan schools. Another recent study was conducted by Toh [43] at the University of Singapore where this study examined the alignment between teachers’ assessments on Calculus materials and the curriculum. Research on alignment in the field of mathematics, especially those related to teachers' assessments, has received little attention. Even in Indonesia, researchers have not found research that examines the alignment of the mathematics curriculum and teachers’ assessment. Existing research only focused on the alignment between the curriculum and the national assessment using Bloom’s taxonomy. The novelty of this study is to explore the alignment between the mathematics curriculum and teachers’ assessments using Bloom's revised taxonomy, namely Anderson and Krathwohl’s taxonomy. However, currently, no research examines the alignment between teachers’ assessments and the curriculum, especially the 2013 Revised Mathematics curriculum for senior high schools in Indonesia, which focuses on developing students’ HOTS.

Furthermore, researchers used Anderson and Krathwohl’s taxonomy to analyze the results. On the other hand, Bloom’s taxonomy is the most well-known and widely used method for classifying assessment tasks, but there are difficulties in implementing it in education [44]. Anderson and Krathwohl revised Bloom’s taxonomy, then they divided the levels of thinking into remembering, understanding, applying, analyzing, evaluating, and creating [45]. Bloom’s taxonomy before revision used nouns at each level, while after revision the taxonomy used verbs to explain each level of thinking. Researchers used the revised Bloom’s taxonomy or known as Anderson and Krathwohl’s taxonomy to analyze the research results. Besides that, there are other taxonomies of thinking that can be used such as Marzano and Kendall’s taxonomy, SOLO taxonomy, or Bloom’s taxonomy, but Anderson and Krathwohl’s taxonomy is used because the taxonomy is in accordance with the characteristics of research involving verbs in mathematics curriculum indicators and teachers' assessments. This is supported by the statement that the consistency of meaning in the use of verbs in the revision of Anderson and Krathwohl’s taxonomy can clarify the meaning of results and assessments for teachers and students [6].

Therefore, the teaching process in the classroom needs to have a cognitive level alignment between the curriculum’s desired outcomes and the assessment activities carried out by the teacher to achieve students’ HOTS. Based on this explanation, research on aligning the cognitive level of the 2013 revised Mathematics curriculum in Indonesia with teachers’ assessments is necessary and vital. Therefore, this research is critical for improving curriculum standards, assessments, and teaching processes to rectify Indonesian education in the future. On the other hand, the results can be used as views and considerations for teachers and prospective teachers of mathematics about the importance of aligning the cognitive level between the assessment and the curriculum, especially those that support students’ HOTS. Therefore, this study aims to explore how the cognitive level alignment between the teachers’ assessments and the 2013 revised Mathematics curriculum for senior high schools in Indonesia related to students’ HOTS based on Anderson and Krathwohl’s taxonomy.

2. RESEARCH METHOD

2.1. Research design

This study aims to explore the alignment between the 2013 revised Mathematics curriculum in Indonesia and assessments arranged by teachers regarding the development of students’ HOTS in terms of content and cognitive level alignment. This descriptive research used a qualitative approach. Researchers used a qualitative approach because qualitative research provided designs that answer research problems through exploration and developing a detailed understanding of a phenomenon [46]. This study also used exploratory, descriptive research because the researcher described, explained, and analyzed the data and facts found in the field, which were further written in the narrative form [47] about the alignment between the 203 revised Mathematics curriculum in Indonesia and the assessment given by teachers to senior high school students in terms of content and cognitive level based on Anderson and Krathwohls’ Taxonomy Indicators [45].

2.2. Participant

The participants in this study were Indonesian mathematics teachers from senior high schools. The researcher used purposive sampling techniques or judgment sampling to select participants who are proficient and well-informed, have the ability to communicate experiences and opinions in an expressive, reflective, and articulate manner, and are willing to participate from different locations to discover the observed phenomena [48]. The selected participants have heterogeneous categories with certain criteria, that were i) they used the 2013 revised Mathematics Curriculum; ii) they taught at city and district schools; iii) they had more than 10 years of teaching experience; and iv) they were willing to participate in this study. The researcher chose public school in Malang City as the school representative in the city while the school representative in the district, the researcher chose public school in Nganjuk District and the two schools were located in East Java, Indonesia. The selection of teachers who teach at the city and district schools aims to explore the diversity of their assessment that are aligned or not with the indicators of the mathematics curriculum. The results of the previous study highlight that there are differences in the teachers' assessment in rural and city areas that affect student learning outcomes [49]. The teachers who participated in this study were 15 mathematics teachers with six male teachers (40%) and nine female teachers (60%). Teachers who were participants in this study were coded (T1, T2, T3, T4,.., T15). Table 1 shows the mean and standard deviation for the age of the participants.

From Table 1, both female and male teachers have the lowest age of 37 years and the highest age of 58 years. Furthermore, the age range of the teachers who participated in the study was 21 years. The average age for female teachers is 49.22 years with a standard deviation of 7.69. On the other hand, the average age for male teachers is 48.67 years with a standard deviation of 7.31.

Table 1. Descriptive statistics for the age of teacher participants

	N	Range	Minimum	Maximum	Mean	Std. deviation
Male	6	21	37	58	48.67	7.312
Female	9	21	37	58	49.22	7.694

2.3. Data collection

The data used in this study were obtained from the results of the arrangement of Mathematics assessment questions by participants, indicators of Mathematics Curriculum and the results of semi-structured interviews. Before the research was carried out, the researcher conducted an FGD with the participants to instruct all teachers that they were asked to collect the assessments that they had or are currently compiling. Then, the teacher submits the results of their assessment by email within 1-3 weeks. The teacher's assessment document was obtained by researchers from the results of the preparation of independent teacher assessments that they used for student assessment in the classroom. The mathematics curriculum document used in this study was the 2013 revised Mathematics curriculum for senior high school. The researcher collected the teacher assessment documents because they were by the characteristics of the data needed in the study, namely the assessment based on the 2013 revised Mathematics curriculum and the HOTS-based assessment.

2.4. Research instruments

The main instrument in this research is the researchers themselves. Then, the supplementary instruments used for this study include indicators of the level of thinking of Anderson and Krathwohl and semi-structured interview guidelines. The indicator of thinking level of Anderson and Krathwohl was used to determine the cognitive level of the assessment made by the teachers and the curriculum indicator used. The overview of the level of thinking indicators in Anderson and Krathwohl's taxonomy shows in Table 2. One expert lecturer in mathematics education at the State University of Malang and two mathematics teachers have validated the research instrument. Several revisions were made by researchers to improve and improve the quality of the instrument, namely revising the indicators of the level of thinking that were adjusted to the definition of each cognitive process based on Anderson and Krathwohl's taxonomy and improving sentence diction in the interview guide to make it more communicative. In the interview session, participants responded to a list of semi-structured interview questions, as shown in Table 3. The interviews were recorded in audio-video form. The semi-structured interview guideline was used to find out more about the teacher's knowledge and views about the alignment of the cognitive level between their assessments and the 2013 revised mathematics curriculum, especially HOTS-based assessments. The data from the interviews were used to enrich and triangulate data attained from the teachers' arrangement of assessment tasks.

2.5. Data analysis

In the current study, the data analysis technique used was based on the analysis model [50], including i) data reduction; ii) data presentation; and iii) conclusion. In data reduction, there were two phases of data analysis, namely the categorization and interview transcription phases. The data was only focused on the results of teachers' assessments aligned with the content and cognitive level of the curriculum. The curriculum document used in this study was the 2013 revised Mathematics curriculum document for tenth, eleventh, and twelfth graders.

Table 2. Indicators the cognitive thinking level of Anderson and Krathwohl

Cognitive level	Definition	Indicator(s)
1. Remembering: retrieving relevant knowledge from long-term memory		
1.1.Recognizing	Finding knowledge in long-term memory that matches the presented material.	Students can name, list, identify, cite, highlight, index, read, mark, and code.
1.2.Recalling	Using relevant knowledge from long-term memory.	Students can explain, describe, number, show, pair, search, memorize, imitate, record, repeat, review, select, tabulate, write, and state.
2. Understanding: constructing meaning from given instructional information, including oral, written, and graphic communication.		
2.1.Interpreting	Changing from one form of representation (e.g., numeric) to another (e.g., verbal).	Students can change representations, estimate, associate, predict, interpret, and paraphrase.
2.2.Exemplifying	Finding a specific example or illustration of a concept	Students can identify and give examples.
2.3.Classifying	Determining that something belongs to a certain category.	Students can categorize, detail, defend, and mark.
2.4.Summarizing	Abstracting the general theme or main point.	Students can weave, summarize, and annotate.
2.5.Inferring	Drawing logical conclusions from the presented information.	Students can tell, suggest, conclude, and report.
2.6.Comparing	Detecting correspondence between two ideas, objects, and so forth.	Students can distinguish, count, contrast, pattern, and comment.
2.7.Explaining	Building a cause-and-effect model of a system.	Students can define, discuss, expand, describe, explore, and explain.
3. Apply: using certain procedures for solving problems.		
3.1.Executing	Applying procedures to known problems.	Students can sort, determine, apply, describe, suggest, adapt, perform, simulate, tabulate, familiarize, and operate.
3.2.Implementing	Implementing procedures for unknown problems.	Students can assign, execute, calculate, modify, prevent, use, train, explore, investigate, question, conceptualize, process, relate, compose, edit and adapt.
4. Analyze: Breaking knowledge or information into its parts and determining how the parts relate to each other.		
4.1.Differentiating	Distinguishing relevant from irrelevant parts or important from unimportant parts of the presented material.	Students can audit, solve, select, nominate, maximize, order, select, detect, examine, signify, and diagnose.
4.2.Organizing	Determining how parts fit or function within a structure.	Students can organize, animate, emphasize, analyze, diagram, correct, measure, organize and focus.
4.3.Attributing	Determining the point of view, bias, value, or intent that underlies the presented material.	Students can correlate, collect, share, explore, relate, transfer, discover, awaken, rationalize, deconstruct, map, and integrate.
5. Evaluate: Making judgments based on criteria and standards.		
5.1.Checking	Detecting errors in a process; detecting the effectiveness of a procedure as it is implemented.	Students can compare, direct, predict, prove, validate, test, select, decide, correct, and separate.
5.2.Critiquing	Detecting the suitability of the procedure for a given problem.	Students can assess, clarify, detail, measure, support, project, and criticize.
6. Create: Arranging elements together to form a coherent or functional overall result; rearranging elements into a new pattern or structure.		
6.1.Generating	Generating alternative hypotheses based on criteria.	Students can collect, build, combine, generalize, compose, code, formulate, and display.
6.2.Planning	Designing procedures to solve some problems.	Students can organize, plan, dictate, cope, design, prepare, and compose.
6.3.Producing	Creating new ideas, products, or ways of viewing things.	Students can abstract, create, shape, improve, combine, repair, produce, reconstruct, combine, facilitate, and construct.

Table 3. Questions of the semi-structured interview guideline

Context		Question(s)
HOTS	1)	In your opinion, what are the indicators of HOTS from a student's perspective?
	2)	….
Mathematics curriculum	1)	When arranging the learning indicators that you want to achieve, do you always base them on the basic competencies of the mathematics curriculum?
	2)	….
Assessment	1)	Explain why your assessment belongs to one of the cognitive levels of the HOTS?
	2)	….
Alignment of content and cognitive level	1)	How are your assessments aligned with the content and cognitive level of the curriculum?
	2)	….

In the categorization process, first, the researcher identified the content and cognitive level of the 2013 revised Mathematics curriculum indicators used by the teacher. Then, researcher categorized them into low order thinking skills (LOTS): remembering, understanding, and applying or HOTS: analyzing, evaluating, and creating. The number of Mathematics Curriculum indicators obtained in this study came from indicators used by teachers to arrange assessments that had been sent to researchers via email. The researcher matched the verbs from the mathematics curriculum indicators with the Anderson and Krathwohl taxonomy indicators in Table 2. However, there were difficulties in categorizing the cognitive level of the curriculum indicators used by the teacher. The use of the same verbs between teachers' curriculum indicators and Anderson and Krathwohl's taxonomy indicators does not mean that they have the same cognitive level. For example, the indicator is "Formulating linear equations and/or inequalities of one variable containing the appropriate absolute value in contextual problems" using the verb at the highest level of Anderson and Krathwohl's taxonomy: create, namely "to formulate" as in Table 2. However, the researchers categorized this indicator as being at the applying level because the indicator only asks students to carry out a certain procedure to produce a linear equation and/or inequality of one variable. Therefore, an in-depth analysis was needed to identify the actual use of verbs that the indicators of curriculum want to achieve. Figure 1 shows the percentage of the analysis result of the mathematics curriculum indicators.

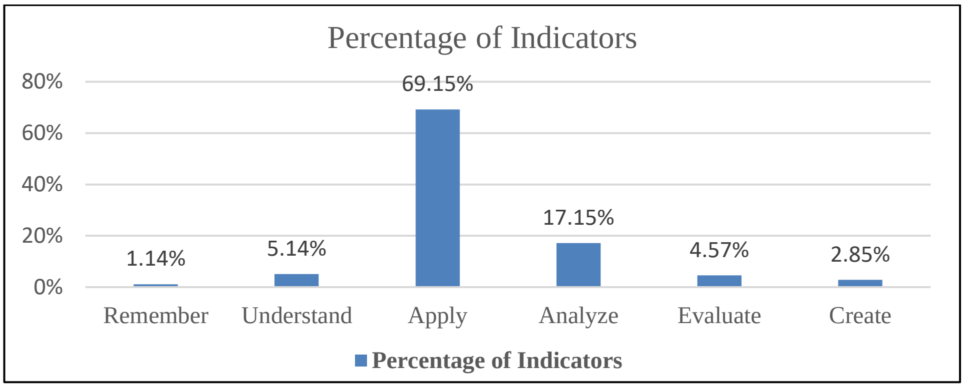


Figure 1. Percentage of the mathematics curriculum indicators

Second, the researcher continued to identify the content and cognitive level of the teachers' assessments and then categorized them into LOTS or HOTS. The number of assessments presented was obtained by the assessments sent by 15 participating teachers to researchers via email. Each assessment given to the researcher was then analyzed and categorized based on their cognitive level using the Anderson and Krathwohl taxonomy indicators in Table 2. Similar to the categorization of indicators of the mathematics curriculum, researchers are also not only dependent on the use of verbs from teacher assessments, but researchers need to examine more deeply the intent of the teacher-made assessments to categorize them into low or high levels. For example, an assessment is "City A has a population of 1 million at the beginning of 2000. The annual population growth rate is 4%. Count the city's population at the beginning of 2003!" use the verb "count". If based on the Anderson and Krathwohl taxonomy indicators, the assessment belongs to the understanding level. However, after the researchers studied deeper and analyzed the desired goals of the teacher's assessment, the researchers placed the assessment at the cognitive applying level because students not only used certain formulas to calculate the city's population but students had to carry out routine procedures related to arithmetic and geometric rows and series. Figure 2 shows the percentage of the analysis result of the teachers' assessments.

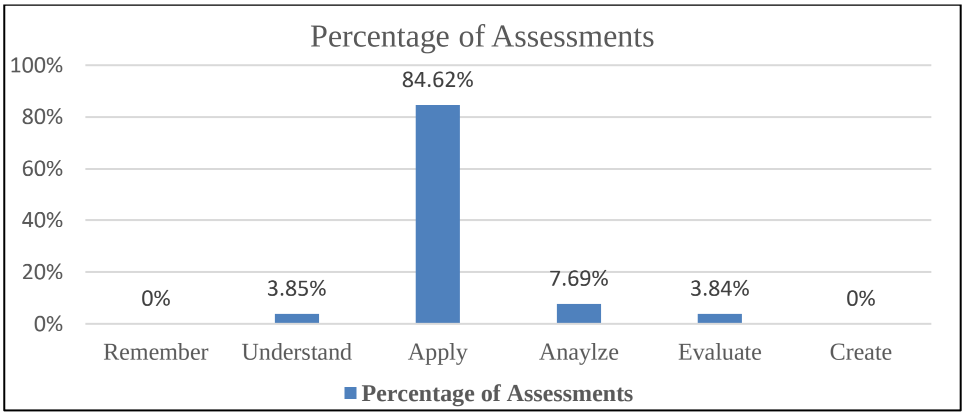


Figure 2. Percentage of teachers' assessments

After the researcher identified the content and cognitive level of the curriculum and teachers' assessments, the next step was determining the alignment of the content and cognitive level of the teachers' assessment task with curriculum indicators. The researcher first determined the alignment of the content from the assessments and curriculum, then the alignment of the cognitive level. Furthermore, the researcher found that teachers could make several assessment tasks using only one indicator, so the number of indicators and assessments compiled by the teacher was different.

All of the indicators and assessments were analyzed and categorized by the researchers in depth. If there were differences in categorization between researchers, the researchers discussed them again and made a final decision that was agreed upon by all researchers. The procedures used to determine the alignment of the assessments and the curriculum followed the procedures in previous studies [6]. After the data reduction process, the researcher then presented the data in the form of descriptive text supported by pictures of the research results. The final step in data analysis was drawing conclusions based on the data, not the researcher's viewpoint.

The data was confirmed to be valid because the data were analyzed using research instruments including Anderson and Krathwohl's taxonomy thinking indicators and semi-structured interview guidelines that have gone through a validation process by experts. The techniques used to determine the credibility of the research result were i) triangulation technique using the methods of data collection (assessment documents and interviews) [1], where researchers compared the results with different data sources, namely assessment documents with the audio-video during interviews session with each participant; and ii) the data confirmation which is obtained by eliminating the researcher's personal view in collecting data by making cognitive thinking level guidelines and semi-structured interview guidelines.

3. RESULTS AND DISCUSSION

3.1. Cognitive thinking levels represented by mathematics curriculum

The results showed that participants used indicators based on basic competencies in the Mathematics Curriculum, including knowledge and skill competencies, which were categorized into low-level and high-level. The findings showed that the indicators of the 2013 Revised Mathematics curriculum used by the teacher target the LOTS level of thinking more than the HOTS. It is proven by the curriculum indicators involving LOTS are 132 of 175 indicators, while only 43 other indicators involve HOTS. In fact, researchers only found 5 of 175 indicators at the creating level, and most of the indicators were at the level of applying (121 of 175 indicators). Table 4 presents the category of 2013 revised Mathematics curriculum indicators.

Table 4. Categorizing of mathematics curriculum indicators

Category	Cognitive level	Number of indicators	Total
LOTS	Remembering	2	132
	Understanding	9	
	Applying	121	
HOTS	Analyzing	30	43
	Evaluating	8	
	Creating	5	
Total of indicators			175

The findings showed that the 2013 revised Mathematics curriculum indicators were dominated by LOTS levels of thinking than the HOTS. These findings are also supported by data from interviews with participants, as shown by the interview transcript between the researcher and participant T3.

> "*In your opinion, does the mathematics curriculum contain HOTS?*" (Researcher)
> "*In my opinion, the Curriculum for Mathematics already contains HOTS, although there are still a few.*" (T3)
> "*Then, when arranging indicators, do you always arrange them based on the basic competencies of the curriculum?*" (Researcher)
> "*Of course, it's always based on basic competencies (BC). For example, BC asks students to analyze, so the indicators used must also be at the analyzing level. But before reaching that level, students must first ensure that they have met the indicators at the level of understanding and application.*" (T3)

Table 5 shows one indicator of the 2013 revised Mathematics curriculum at the LOTS level, namely application used by T2 and HOTS level and analysis used by T1, along with transcripts of interviews with these participants. T2 provided an example of an indicator at the cognitive level of applying conveyed in arithmetic sequence content. This indicator only targets students to be able to use the formula in an arithmetic sequence. Students only determine the n^{th}-term in the sequence. Meanwhile, an example of a high-level 2013 revised Mathematics curriculum indicator of analysis is shown by T1. In this indicator, T1 combined the contents of an arithmetic sequence and a geometric sequence. T1 aimed that students not only use routine algorithms such as determining the n^{th}-term or the sum of the first n-terms of arithmetic and geometric sequences but students were asked to analyze the geometric sequence first and then find its relationship with the new arithmetic sequence that formed from the previous geometric sequence.

Table 5. Examples of mathematics curriculum indicators used by participants

Cognitive level	Content	Mathematics curriculum indicators	Response
LOTS: applying	Arithmetic sequence	Given an arithmetic sequence, the student can determine the n^{th}-term of the arithmetic sequence.	"*When I arrange the indicators, I will definitely align them first with their basic competencies. Here is the basic competency that I used in grade 11. First, generalizing the pattern of numbers and Arithmetic and Geometric Sequences. So that the indicator (s) that I expect for students, first they understand the number pattern, then students can generalize the number pattern. Finally, students can determine the n^{th}-terms of arithmetic or geometric sequence*." (T2)
HOTS: analyzing	Arithmetic and geometric sequence	Students can analyze the n^{th} term of a geometric sequence that can produce arithmetic sequences.	"*To construct indicators at the analysis level, I combine the contents of arithmetic and geometric sequences. I do this so that students don't just use routine procedures to calculate n^{th}-terms or the sum of n-terms in arithmetic and geometric sequences*." (T1)

3.2. Cognitive thinking levels represented by teacher assessments

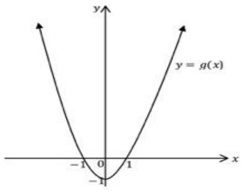
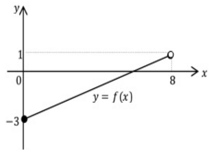
The results also showed that the assessment tasks arranged by participants were categorized as low and high cognitive levels. Assessment tasks using HOTS were 21 of 182 assessment tasks, while the remaining 161 assessment tasks used low-level thinking skills. These results illustrated that teachers are more dominant in giving assessment tasks in the LOTS category than in HOTS. Linearly, another research found that the teacher's assessment task was limited to targeting students' low-order thinking skills such as the level of understanding: explaining than HOTS-based assessment tasks [51] than HOTS-based assessment tasks [52]. Furthermore, the findings of this study also showed that as many as 154 teachers' assessment tasks are at the applying level. In addition, there were only a few teachers' assessments that targeted students' high-level thinking skills. There were 14 assessment tasks at the analyze level, seven assessment tasks at the evaluate level, and no teacher assessment tasks measuring students' abilities at the create level. Table 6 presents the category of Mathematics assessment tasks arranged by participants.

Table 6. Categorizing of teacher assessments

Category	Cognitive level	Number of assessments	Total
LOTS	Remembering	0	161
	Understanding	7	
	Applying	154	
HOTS	Analyzing	14	21
	Evaluating	7	
	Creating	0	
Total of assessments			182

Most teachers' assessments target students' low-level thinking skills at low levels, especially applying skills rather than high-level skills. Table 7 shows one of the mathematics assessment tasks arranged by participants, along with a transcript of the results of interviews with these participants. The assessment task at the LOTS level, namely understanding skills, was shown by participant T5 and the task at the HOTS level, namely evaluating, was shown by participant T6. T5 provided an example of an assessment at the level of understanding in which students must determine the domain(s), range(s), and graphic equation(s) from the given images of the function, namely linear functions and quadratic functions. Meanwhile, T6 provided examples of an assessment task categorized as evaluating level where the task required students to investigate the truth of each provided statement.

Table 7. Examples of teachers' assessments

Cognitive level	Content	Assessments	Response
LOTS: understanding	Graph of linear and quadratic function	Determine the domain, range, and graph equation of the following functions. a)  b) 	"*Students are presented with several graphs of function. Here, I provide two graphs, namely, a graph of a linear function and a quadratic function. Then, the question asks students to determine the domain, range, and equation of each graph. These questions only assess students' understanding*." (T5)
HOTS: evaluating	Trigonometric	Given that the curve $y = \sin x + \cos x$ and the abscissa point $x = \frac{\pi}{2}$. Investigate whether the following statements are true or false. Give your explanation. a) The slope of the tangent to the curve y at the abscissa point $x = \frac{\pi}{2}$ is -2. b) The equation of the tangent to the curve y at the abscissa point $x = \frac{\pi}{2}$ is $y = -x + \frac{\pi}{2} + 1$ c) The point of tangency is $\left(\frac{\pi}{2}, 1\right)$. d) The equation of the tangent line intersects the Y-axis at the point $\left(0, \frac{\pi}{2} - 1\right)$.	"*In this problem, students are given an equation of a trigonometric curve with its abscissa point. Then, I gave some statements that were true and also some that were wrong. I asked students to investigate each of the statements. Students compare the results of their calculations with the statements given. So, the process requires students to assess whether the statement is true or false*." (T6)

3.3. Alignment between indicators of mathematics curriculum and teacher assessments

First, the researcher determined the alignment of the content between the assessments arranged by the teacher and the indicators from the 2013 revised Mathematics curriculum. Furthermore, the researcher found that teachers could make several assessment tasks using only one indicator, so the number of indicators and assessments compiled by the teacher was different. An example of one indicator from participants was, "Given a problem related to the annuity, students can solve the problem with the concept of sequences and series." The indicator could be used to develop two assessment tasks, namely: first, a loan of IDR 10,000,000.00 will be repaid with a monthly annuity of IDR 500,000.00. If the interest rate is 3% per month, determine the amount of the first interest and the first payment and the amount of the 9th payment and the 9th interest; and second, the capital of IDR 12,000,000.00 is loaned at an interest rate of 2% per month for two years. If the loan will be repaid using a monthly annuity system, determine the amount of the annuity. Second, the researcher determined the alignment of the cognitive level between the indicators and the teachers' assessment tasks after deciding the alignment of the content. The results of the analysis of content alignment and cognitive level showed that at the LOTS level, as many as 147 of 154 assessment tasks were aligned with the content and cognitive level of the curriculum, while at the HOTS level, only 12 of 50 assessment tasks aligned with the content and cognitive level of the curriculum, as presented in Table 8.

Table 8. Number of assessments that match the cognitive levels of the curriculum

Category	Cognitive level	Number of indicators from teachers' assessment task	Number of teachers' assessments		
			Aligned[(a)]	Not aligned	
				Below[(b)]	Above[(c)]
LOTS	Remembering	2	0	0	0
	Understanding	9	2/7	0	5
	Applying	121	145/154	4	5
Total LOTS		132	147/161	4	10
HOTS	Analyzing	30	6/37	31	0
	Evaluating	8	6/9	3	0
	Creating	5	0/4	4	0
Total HOTS		43	12/50	38	0
Total		175	159/211	42	10

Note: a) The first number indicates the number of teachers' assessment(s) that match the content and cognitive level of the mathematics curriculum indicator. The number after the "/" sign indicates the total number of assessments that correspond to the mathematics curriculum indicators at that particular cognitive level. For example, the level of understanding, 2/7 indicates that 2 of the 7 assessment tasks are cognitively aligned with curriculum indicators. b) "Below" indicates that the cognitive level of the teacher's assessment is below the cognitive level of the indicator prepared by the teacher. c) "Above" indicates that the cognitive level of the teacher's assessment is above the cognitive level of the indicator prepared by the teacher.

The results revealed that the alignment of the cognitive level of assessment with indicators on the HOTS level is relatively lower than that of the LOTS level. Teachers are better able to align their assessments with indicators at lower levels. However, when assessments of LOTS and HOTS were combined, the researchers found that 159 of the 211 assessment tasks aligned with the cognitive level of the curriculum. These results indicated a moderate level of cognitive and content alignment.

In addition to aligned assessment tasks, the researcher also found 52 assessment tasks were not aligned with the cognitive level of the curriculum indicators. There were 42 tasks that followed the cognitive level of the curriculum indicator and 10 above the cognitive level of the curriculum indicator. Furthermore, the results of the study also revealed that most of the assessment tasks were above the LOTS cognitive level of the curriculum indicators, while many assessment tasks were below the HOTS cognitive level of the curriculum indicators. Figure 3 shows an example of an assessment arranged by T2 with the indicators. These results indicated that T2 composed two assessment tasks using one indicator item. In terms of content alignment, the two assessment tasks made by T2 were about the arithmetic sequence in the form of a contextual problem, namely the row of seats in the theater. This problem matched the content of the indicators used by the teacher, namely arithmetic sequences. While on the cognitive level alignment, the researchers found two results. First, assessment task number 1 made by the teacher was not in line with the cognitive level of the indicator. While assessment task number 2 was aligned with the cognitive level in the indicator.

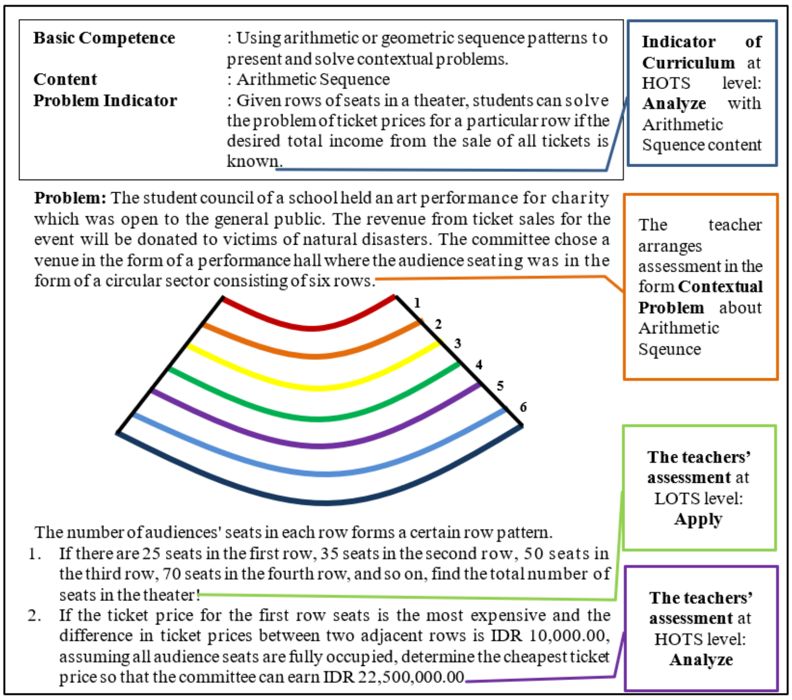


Figure 3. Example of the alignment of content and cognitive level: analyze

Table 9 describes the detailed assessments made by teachers which aligned but were not cognitively aligned with the indicators. Assessment task number 1 only targeted the cognitive level of applying, while the indicator targeted the cognitive level of analyzing. The curriculum indicator used by the teacher is categorized as HOTS at the analyzing level because these indicators aim for students to solve problems related to ticket prices if given particular conditions, so students must break their knowledge about arithmetic sequences into parts to understand and then use them to solve problems related to ticket prices for a certain sequence following the desired total income from the sale of all tickets. However, assessment task number 1 only asked students to determine the total number of seats in the theater. Students could directly use routine procedures to count the total number of seats in the theater consisting of 6 rows, with the first row containing 25 seats and the difference in each row being a multiple of 5.

Furthermore, the findings showed that assessment question number 2 was aligned with the cognitive level of the curriculum indicators. Assessment question number 2, made by the teacher, is categorized as HOTS at the cognitive level of analysis because the assessment asked students to solve problems related to the cheapest ticket prices, with the total income from the sale of all tickets should be IDR 22,500,000.00. Students will use their reasoning to model the mathematics of the problem and then relate it to the concept of arithmetic sequences to get the lowest price for show tickets. Table 10 explains in more detail teachers' assessments that aligned with the content and cognitive level of indicators.

Table 9. Content aligned teachers' assessments that are not cognitively aligned

	Content	Cognitive level	Alignment result
Indicators of mathematics curriculum	Arithmetic sequence T2 said, "*The basic competency I use is arithmetic and geometric sequences*."	Rated at a higher level: analyze. T2 said, "*From this arithmetic content, I want students to be given a stimulus in the form of rows of seats in the theater with the pictures of rows of seats*."	Aligned for content but not aligned for cognitive level. T2 said, "… *But for question number 1, the indicator targets analysis while question number one only counts the number of seats. Students just use the cognitive level of application. So, it doesn't match.*"
Teachers' assessments	Arithmetic sequence T2 said, "*The first problem, the student is asked to determine the total number of seats in the six rows of seats in the theater*."	Rated at a higher level: apply. T2 said, "*The first question has the lower cognitive skill because students only determine the number of seats so that the question includes the level of applying*."	

Table 10. Teachers' assessments are content and cognitive levels aligned: analyze

	Content	Cognitive level	Alignment result
Indicators of mathematics curriculum	Arithmetic sequence	Rated at a higher level: analyze.	Aligned for content and cognitive level. T2 said, "*I think it has aligned like ticket sales, theater performances so that students can imagine and the ticket prices are rational. Then also question number 2 uses the results of calculations from question number 1. The HOTS level on question number 2*."
Teachers' assessments	Arithmetic sequence T2 said, "*After students know the number of seats in each row of seats and the total number of seats, students are given information about the total income and asked to determine the cheapest ticket price from that row of seats.*"	Rated at a higher level: analyze. T2 said, "…, *then question number 2 is included in the level of analyzing. I classify the question at the analysis level because the stimulus is only given a total income of IDR 22,500,000.00 and asked students to find the cheapest ticket price. Students should model the mathematics first.*"	

3.4. Discussion

The first findings showed that the indicators of the 2013 revised Mathematics curriculum used by teachers when teaching in the classroom are more at a low cognitive level than at a high cognitive level. This is supported by the results of other studies, which explain that the desired output of the curriculum is more in the low-level category than the high-level. First, Hassan and Baassiri [35] found that almost half of the learning objectives of the Lebanese Science curriculum in both public and private schools target low cognitive levels, with no curriculum output targeting evaluate cognitive levels. In fact, a previous study revealed that the learning objectives of the Primary Science Curriculum in Korea on the cognitive dimension lean towards remembering and understanding (87.3%) while in Singapore they lean towards understanding and applying (86.7%) [53]. These results are supported by Susandi *et al.* [54] study in Indonesia, discovering the learning model and books suggested by the mathematics curriculum had not deeply explored students' critical thinking abilities.

The second findings of the study also indicated that teachers have not been able to arrange assessments at a high cognitive level. It can be seen that the assessments made by teachers are mostly only at the low cognitive level, especially at the level of application. Similar findings from another study also suggest that teachers often arrange class assessments in the form of exam questions that only target LOTS [55]. These results are in line with the statement that teachers still experience challenges when providing HOTS teaching and learning at school [56]. Previous study discovered that prospective mathematics teachers rarely used interpretive explanations to develop students' thinking skills [57]. Further findings stated that prospective mathematics teachers do not yet have critical thinking skills, which include a high level of thinking, as well as findings. On the other hand, students with low thinking ability will have difficulty and perplexity while making many mistakes in solving problems [33]. Similar research also states that the lack of high motivation from teachers to improve their competence can hinder students' skills development [58]. In fact, teachers as educators have an essential role in determining student success [15]. Furthermore, teachers are expected to be able to provide HOTS-focused learning [59]. Research conducted in Malaysia showed that it is essential to incorporate HOTS in the classroom learning so that students are inclined to think critically and creatively in everyday life [37]. The results of this study also found that teachers have not been able to compile an assessment at the creating cognitive level. Previous studies have shown that teachers should apply HOTS-oriented learning and assessment to develop students' thinking skills and increase student achievement [8], [11].

Last, the results of the alignment of cognitive level between teachers' assessments and the 2013 Revised Mathematics curriculum in the HOTS category are relatively low. Many teachers' assessments presented lower cognitive levels than the curriculum indicators for the higher-level thinking skills. The results of similar research also showed that many teachers' assessments do not match the cognitive level of the curriculum output, with most of these assessments being below the cognitive level of the curriculum [6], [60]. In fact, the assessment tasks given to students should not target a cognitive level below the curriculum's desired outcome so that there is a discrepancy between the teachers' assessment and the curriculum [61]. Other researchers highlighted that the way teachers align their assessments with curriculum outcomes will "make things easy for students" to achieve the desired results within subjects [62]. Assessments compiled by teachers must match the cognitive level of the curriculum [31] especially at a high cognitive level. In addition, previous research also stated that there is a lack of alignment between teacher assessments and the curriculum [35], [38]. Furthermore, alignment between assessments and curriculum standards carries a problem for the state, as curriculum standards cover all important concepts that students must know and can do, while the assessments provided by teachers only cover a small part of these standards due to the teachers' limited time for teaching students in the class [63]. Meanwhile, curriculum alignment is crucial in realizing learning outcomes because misalignment will have a negative impact on the development of students' knowledge and skills [64].

The results on the alignment of cognitive levels between curriculum and assessment are important to do. This is supported by the statement that the alignment between assessment and curriculum is critical for the quality of learning to optimize student learning and ensure that each activity achieves learning objectives [41], [64]. Furthermore, curriculum and teacher knowledge of curricular goals and structures are valuable tools that teachers often use to facilitate student learning and make decisions about what assessments to use in class [65], so the teacher's assessment and curriculum objectives must match. On the other hand, teachers must also be required to prepare HOTS-based assessments whether they are delivered directly or indirectly in the curriculum [66]. Other studies highlight that learning and assessment that emphasize HOTS will help students become good thinkers so that they are trained to solve a problem at hand [67]. Besides, this study indicate that both teacher assessment documents and the 2013 Revised Mathematics Curriculum dominantly target low-level skills and teachers have difficulty compiling HOTS-based assessments and applying these assessments to students. These results are supported by research that highlights that the knowledge and ability of teachers to develop HOTS-based assessments are still relatively low and most students are not familiar with assessments at a higher cognitive level [14]. In fact, the alignment between assessment and curriculum at a higher cognitive level provides an opportunity for teachers to improve students' abilities [6].

3.5. Limitations

There are several limitations to the current study. First, with only 15 used teachers from two high schools, it is difficult to say whether or not this sample is representative of the entire high school. Then, the document used by the researcher is only one, that is the 2013 Revised Mathematics curriculum for senior high schools, whereas, in Indonesia, various curriculum documents have been implemented. The next limitation is the analysis of the cognitive level alignment between teacher assessments and the curriculum only using a thinking taxonomy, namely Anderson and Krathwohls' taxonomy. On the other hand, there are many taxonomies that can be used for thinking level analysis such as SOLO taxonomy, Marzano and Kendalls taxonomy, or Blooms taxonomy. The use of curriculum documents and other thinking taxonomies may result in different alignments for each cognitive level. For example, the cognitive process of evaluation becomes the highest cognitive level in Bloom's taxonomy while the highest cognitive level of Anderson and Krathwohl's taxonomy [2] is creating and placing evaluation below that level. This study also only focuses on higher-order thinking skills contained in curriculum indicators and assessments made by teachers. The use of other curriculum documents and at other school levels such as primary or junior secondary schools may result in a number of different HOTS and LOTS-based teacher indicators and assessments.

4. CONCLUSION

The results showed three main findings related to the alignment of cognitive levels between teachers' assessments and the 2013 Revised Mathematics curriculum in Indonesia. The first finding showed that the 2013 revised Mathematics curriculum indicators used by teachers mostly target students' low cognitive thinking skills. Most Mathematics curriculum indicators are at the cognitive level of applying, and the least is at the cognitive level of creating. Then similarly, the second finding showed that teachers' assessments are also more dominated by the low cognitive level compared to the high cognitive level. Teachers compile most of the assessment tasks at the cognitive level of applying, and teachers are not able to arrange assessment tasks at the cognitive level of creating. Then, the alignment of content and cognitive level between Mathematics curriculum indicators and teachers' assessment tasks in the HOTS category were also low. Teachers can better align their assessment tasks with indicators at a low cognitive level. Most of the teachers arrange the assessment task with lower cognitive levels than the HOTS cognitive level of the curriculum.

These results can be used as views and considerations for teachers and prospective mathematics teachers about the importance of aligning the cognitive level between the assessment and the desired outcome of the curriculum, especially those that promote students' HOTS. The results can also provide guidance to teachers on the use of a taxonomy of thinking to compile assessments, therefore they can improve curriculum standards, assessments, and teaching instructions in the classroom. Based on the limitations, the authors suggest future researchers to follow up on similar research, namely alignment research by using other curriculum documents and involving many teachers who are able to compile various types of assessments such as project assessments, portfolio assessments, or performance assessments.

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