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Reconstruction of Higher Order Thinking Skill Through Enriching Student's Argumentation Skills

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Abstract: Reconstruction of Higher Order Thinking Skill through Enriching Student's Argumentation Skills. Objectives: This study aims to reconstruct the high-level skills of students through enrichment of argumentative skills. **Methods:** This research is a qualitative descriptive study involving the population of class XI high school students in Bandar Lampung. The number of samples involved in this study were 65 students. Data collection techniques used in the form of in-depth observation through interviews and written tests. **Findings:** Based on data analysis of written arguments produced by students about the problem presented, the average student is in a Level 1 coding scheme (above 60%). This indicates that there has been a cognitive process that has led to the ability to identify questions, facts, relevant knowledge, creative ideas, and formulate predictions. **Conclusion:** Thus it can be concluded that the enrichment of argumentative skills are able reconstructstudent's higher order thinking skills.

Keywords: HOTS, argumentation skills, cognitive process.

Abstrak: Rekonstruksi Keterampilan Berpikir Tingkat Tinggi melalui Pengayaan Keterampilan Berargumentasi. ***Tujuan:*** *Penelitian ini bertujuan untuk merekonstruksi keterampilan tingkat tinggi siswa melalui pengayaan keterampilan berargumentasi.* ***Metode:*** *Penelitian ini merupakan penelitian deskriptif kualitatif dengan melibatkan populasi kelas XI siswa sekolah menengah atas di Kota Bandar Lampung. Jumlah sampel yang terlibat pada penelitian ini sebanyak 65 siswa. Teknik pengumpulan data yang digunakan berupa observasi mendalam melalui wawancara dan test tertulis.* ***Temuan:*** *Berdasarkan analisis data argumen tertulis yang diproduksi siswa tentang masalah yang tersaji rata-rata siswa berada dalam skema pengkodean Level 1 (diatas 60%). Hal ini mengindikasikan bahwa telah terjadi proses kognitif yang mengarah pada kemampuan mengidentifikasi pertanyaan, fakta, pengetahuan yang relevan, kreasi ide, dan merumuskan prediksi.* ***Kesimpulan:*** *Dengan demikian dapat disimpulkan bahwa pengayaan keterampilan berargumentasi dapat merekonstruksi keterampilan berpikir tingkat tinggi siswa.*

Kata kunci: *keterampilan berpikir tingkat tinggi, keterampilan berargumentasi, proses kognitif.*

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INTRODUCTION

Facilitating the development of students' cognitive abilities in learning is one of the goals of physics learning. One of the things that can be done is to change and train students' patterns of engagement through exploration and experimental activities in learning. Cobb (1994) states that in constructivist theory students need to be given learning experiences that make it possible to build knowledge and promote their thinking skills. Furthermore, Gagnon & Abell (2008) explained that in order to realize this, scientific activity automatically becomes a requirement in science classes. This activity clearly forms the ability of cognition (honing traits) that is in accordance with students' thinking in a sematic network. This has an impact that the learning of science requires a relationship between evidence and statements (Wu & Hsieh, 2006). On the other hand, it is able to form mental representations that include the ability to consider, reason, describe, solve problems logically, form concepts, kretivitas and intelligence. In science, the process of how to prove data can be done by constructing arguments or explanations (Duschl and Osborne, 2002). So that special strategies are needed to stimulate the construction of student knowledge that is able to confirm a general process and determine an idea in mind so that students can be skilled in: (1) asking scientifically oriented questions; (2) prioritizing evidence; (3) using evidence to formulate statements; (4) evaluating statements based on alternative explanations; and (5) communicating and giving reasons.

Controlling the process of finding ideas in students' minds requires a logical formulation referring to how two actions form a relationship naturally. This can be circumvented by stimulating argumentative skills in the daily learning of students (Duschl and Osborne, 2002). In addition, argumentative skills in science learning act as the implementation of the development of ideas, evidence and arguments in science (Osborne et al., 2004). One of the things that a teacher can do is to control the assessment process which includes a schematic use of the mind more broadly to find new challenges for students or known as higher order thinking skills (HOTS).

The experience of solving problems in an assessment framework needs to be the main exercise in the learning process in the classroom in order to reconstruct higher-order thinking skills. The higher order thinking skills themselves require the ability to manipulate information in new situations (Heong et al., 2011) and the ability to analyze the main capital students must have in high level thinking skills (Osborne, 2013). High-level thinking skills themselves include several things, namely critical thinking, logical, reflective, metacognitive, and creative thinking (King et al., 2015). In addition, higher-order thinking skills require unusual problems and problem solutions that involve thinking and reasoning (Abosalem, 2016; Leou, 2006; Shellens & Valcke, 2005).

Physics is a branch of science that involves many forms of mathematical equations in it, so students must be able to understand these equations not only mathematically, but also physically. In constructing mathematical equations into physical descriptions, students' argumentation skills are required. This is not the case for most students in Indonesia. In constructing mathematical language into physical language requires a deep understanding of the concepts or problems faced by students. Thus, students are able to argue correctly and precisely the mathematical language that is confronted with it.

Many studies have been discussed about student's argumentation skill (Vyanti *et* al. 2020; Cari et al., 2019; Martin & Justi, 2019; Wang & Buck, 2016), but there were no studies concern about how to reconstruct student's higher order thinking skills through argumentation skills. It is

important to be discussed because the low of student's argumentation skill needs to be solved by providing a stimulus in order to reconstruct HOTS students. However, the absence of an alternative solution that can be done by the teacher to reconstruct mathematical language into physical language, becomes a challenge for a teacher. In order to reconstruct the argumentation skills and analyze the patterns of students' analysis frameworks for a given problem, fluid material is chosen with floating and submerged sub-subjects. This is based on the characteristics of the material and the achievement of fluid learning which is very suitable to stimulate students' argumentation skills in order to reconstruct HOTS. This material has a controversy phenomenon that can be identified based on students' initial knowledge which will lead to various statements that can lead to discussions between students. The phenomenon of controversy arising from this material forces students to decide whether an object is floating, sinking or floating based on the density of the object, cross-sectional area, weight of the object or the type of fluid used. It is hoped that by giving this treatment, students will be able to reconstruct HOTS in terms of providing stimulus for argumentative skills in the assessment process.

METHODS

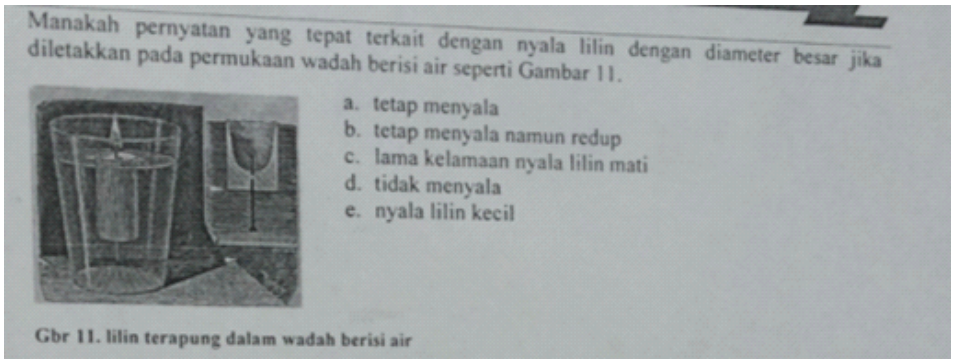
This study is a qualitative descriptive study involving class XI population of high school students in Bandar Lampung City. The number of samples involved in this study were 65 students. Data collection techniques used in the form of deep observation and written tests. Considering that this study is a further study of the structure of the argumentation of the results of development, the test instrument used has been validated and categorized as valid and reliable. The data analysis of this study is based on the pattern of the process of reconstructing higher order thinking skills (HOTS) produced by students. The analysis refers to the systematic definition of cognitive structure. Categorization of the students' answers were divided into 2 levels (Table 1). The pattern of the process of reconstructing higher order thinking skills (HOTS) uses a key structure of the modified Toulmin (1958) argumentation scheme in order to systematically analyze the definition of cognitive structure.

Table 1. The categorization of the students' answers

Category	Indicators
Level 1	cognitive processes occur that lead to the ability to identify: (a) questions (focus on concluding statements), (b) facts that are known (implicit in the problem), (c) relevant knowledge (initial knowledge), (d) creating in building ideas / ideas and (e) formulation of prediction of final results
Level 2	a cognitive process occurs that leads to the ability to: (a) specify aspects / elements of the problem; (b) compile statements based on facts / information

RESULTS AND DISCUSSION

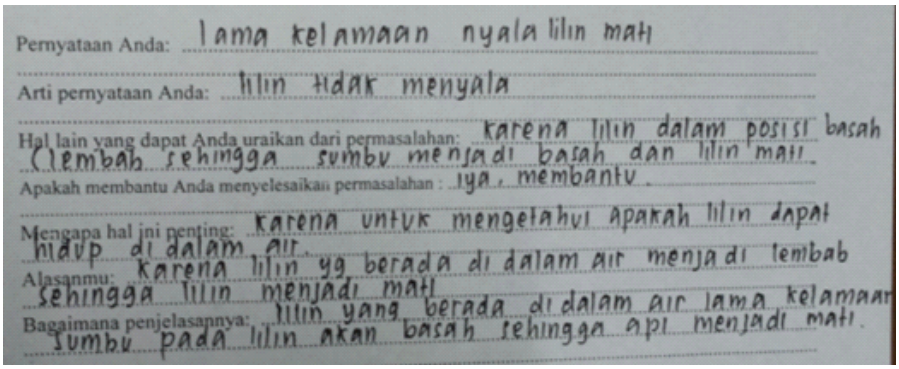
The process of defining cognitive models that can describe the relationship between memory structures and sematic networks during the process of practicing argumentation skills. Students are directed to focus attention on the type of statement to represent their knowledge. This activity gives students control over the strategy and ability of students to produce their best statements. The problem and problem solving for defining cognitive structure systematically which is connected with practicing argumentation skills is presented in Figures 1 and 2.


Manakah pernyatan yang tepat terkait dengan nyala lilin dengan diameter besar jika diletakkan pada permukaan wadah berisi air seperti Gambar 11.

a. tetap menyala
b. tetap menyala namun redup
c. lama kelamaan nyala lilin mati
d. tidak menyala
e. nyala lilin kecil

Gbr 11. lilin terapung dalam wadah berisi air

Figure 1. The problem of reconstructing HOTS through activities enrich students' argumentation skills


Pernyataan Anda: lama kelamaan nyala lilin mati

Arti pernyataan Anda: lilin tidak menyala

Hal lain yang dapat Anda uraikan dari permasalahan: karena lilin dalam posisi basah (lembab sehingga sumbu menjadi basah dan lilin mati.

Apakah membantu Anda menyelesaikan permasalahan : iya, membantu.

Mengapa hal ini penting: karena untuk mengetahui apakah lilin dapat hidup di dalam air.

Alasanmu: karena lilin yg berada di dalam air menjadi lembab sehingga lilin menjadi mati

Bagaimana penjelasannya: lilin yang berada di dalam air lama kelamaan sumbu pada lilin akan basah sehingga api menjadi mati.

Figure 2. Examples of student problem solving

Figure 1 represents how the problem can be analyzed to indicate the response to the given grid. Students must think about how to signify the statement to be produced by a variety of configurations that are driven by the search for problem solutions. That is, the configuration of students' thinking is a sign of cognitive processes broken down into concrete steps which are then used as guidelines for thinking. The application of configuration in problem solving to Figure 1 as a framework that is quite challenging and consistently determines the level of student argumentation skills that stimulates the reconstruction of higher-order thinking. Syam & Efwinda (2018) uses mind widely to find new challenges as part of higher order thinking skills.

One example of reconstructing thinking skills in the problem of Figure 1 is that students must discover how to light a candle with a large diameter if placed in a container filled with water.

Reconstruction of thinking that is expected to emerge from students related to Figure 1 is; the ability of students to define as the ability to connect various clues and facts or information with the knowledge they have to make a prediction of the final result that is formulated. Boddy et al., (2003) state that promoting students' thinking skills becomes a focus in the learning process. The argumentation configurator in this framework is able to demonstrate the level of student argumentation skills effectively. Erduran et al. (2004) the configuration of arguments versus reasson and arguments versus rebuttal challenges students' ideas.

The configuration of the production of student statements related to the problem presented in Figure 1 is generated in Figure 2. Figure 2 represents simply the statements produced by students are statements with supporting information as alternative statements (eg: "candle is not lit"). Toulmin (1958) provides a structural framework that can be used to analyze arguments and to develop skills in generating arguments. The Toulmin framework (1958) helps students produce and develop scientific reasoning and evidence-based explanations. This phase generates responses and is coded independently by researchers using categories from phase 1 as a rubric of assessment. Based on the data (Figure 2) written arguments produced by students about the problem presented by the average student are in a Level 1 coding scheme (above 60%). Coding for the average student's answer for all questions given are shown in Table 2.

Table 2. The categorization of the students' answers

Average Value of Students' Answer							Total Average	%
1	2	3	4	5	6	7		
3.8	3.1	3.2	3.1	3.1	2.4	2.3	3	60

Coding situations (level 1 above 60%) of the argumentation skills produced by students (Figure 2) illustrate the situation of students' interactions with the problem to be solved (eg: "because the candle is in a wet (moist) position so the wick becomes wet and the candle dies"). The process of solving problems (Figure 2) requires a high level of reasoning in order to reconstruct thinking skills. The ability of students to think logically is needed in solving problems in Figure 1. Besides that, students' abilities are needed to use their knowledge, understanding, and skills and connect them to new situations. Heong (2011) Higher level thinking skills is a way to find new challenges by using thinking. As a result students must have the ability to manage new information or knowledge in order to reach answers in new situations.

In this situation students are challenged with a variety of statements, experiences, trust in data, or data used to produce statements. Kelly and Takao (2002) revealed that students' argumentation skills can be understood not only in written form but through various applications of argumentation (eg conversation). So that new statements are produced based on the results of in-depth interviews (eg: "the candle stays burning, rises slowly above the water surface. The reason is that the flame forms a well around the wick filling with liquid wax, while the water outside the candle wall remains"). In this phase (eg conversation), students are guided to make 'yes',

'no' or 'I don't know' decisions related to the initial statement they produce. Wilks (1995) revealed that learning experiences focused on analytical, evaluation and synthesis activities, develop skills in problem solving, inferring, estimating, predicting, generalizing and creative thinking where all of these activities are considered as sequences of higher order thinking skills. Therefore, student activities using writing frames with help questions produce many statements of reason.

This phase also (Figure 2) gives students relatively long space and time so that it allows students to produce statements based on analysis using a theory of causal approach. Zohar & Dori (2003) states that the skills of producing statements, decision making, and critical and systemic thinking are seen as strategies to train higher thinking. This activity is needed to achieve high level thinking skills recronstruction for floating and submerged material. Besides this phase is a HOTS reconstruction pattern by focusing on how the first reasoning and argumentation produced by students. This is the basis for students to recognize the causal relationship between theory and evidence so that students' reasoning and argumentation skills develop well. The HOTS reconstruction structure in this framework supports the Higher-order tinking skill function of students with the coherence between claims and evidence. Dillon (2002) Thinking skills can be promoted during the learning process to reconstruct higher order thinking. As a result the coherence of this thinking skill arises and develops naturally during the learning process which is one of the conditions for the functioning of HOTS students. Although there are different ways to understand the order to achieve higher thinking (Cari et al., 2019). The way that is described is described as an 'umbrella' which includes various forms of thinking such as critical, systemic, and creative thinking.

Production of student arguments in Figure 2 and in-depth interviews illustrate the process of understanding the production of arguments produced by students. The combination of writing and interview aspects focuses on the concrete ways in which students and teachers relate to developing an argument by taking responsibility for justification of the statement produced. With the burden of proof "Candles keep burning" the next statement is formulated with the pattern (1) "meaning of your statement (result: As a floating candle burns, the candle is used as fuel for fire. This makes the candle lighter and floats higher inside container filled with water). (2) Another thing that you can describe from the problem (result: The buoyancy force on the candle is almost unchanged while the weight of the candle is reduced by burning). (3) Does it help you solve the problem: (result: the buoyancy force on a floating object will be greater than the density of the fluid; in the event of a float, only a part of the volume of the object is immersed in the fluid so that the fluid volume that moves is smaller than the total volume of the object being float; because *Vt* (volume of immersed object) is smaller than Vb (total object volume), the condition of the floating object is: the buoyancy force Fa is equal to the weight of the object w or $Fa = w$; and the density of the object must be smaller than the density of the fluid or $\tilde{n}b < \tilde{n}f$. The production of statements that are configured in a single frame find the right solution to the problems presented covering every corner of student activity in order to help students solve problems regarding high-level cognitive processes. Keywords given guide students to integrate assessment strategies that promote the reconstruction of skills Students think at a high level integrate answer guides to produce statements that encourage students to think. The phenomena presented lead to pragmatic phenomena related to floating and submerged matter.

Pragmatic phenomena are directly used as a foothold on how students are able to find a solution to a specific problem by responding, choosing, and testing responses. Ben-Chaim et al. (2000) revealed that the reconstruction of Higher-order thinking skills is high in order to facilitate students' knowledge and skills into responsible action. Student responses include ideas related to cognitive activities that precede thought and perception. For example: "over time a dead candle flame (the tendency of students to perceive phenomena in accordance with events in general), this situation makes it difficult for students to produce different statements from other friends; candles do not light (continued stimulus offered by students provides students 'perceptions of thought through more active participation in interpreting the stimulus provided. On the other hand this stimulus is also able to inhibit students' perceptions due to repeated attempts to repeat the solution: "because the candle is in a wet position (moist) so that the wick becomes wet and the wax dies; (labeling a phenomenon into the student's mind can facilitate students looking for alternative statements.) This gives the fact that the problem solving process of a phenomenon has certain stages that allow students to confirm the initial statement presented then an alternative statement will emerge.Zoller et al. (2000), to meet the challenge of reconstructing high-level thinking skills requires a foreign situation that students need to analyze so that questions, questions, mechanism of problems, and decision-making abilities will be based on the framework rational thinking.

■ CONCLUSIONS

Systematically defining cognitive structures to reconstruct student's HOTS trough activities enriching argumentation skills as a process of describing the relationship between memory structures and sematic networks during the process of practicing argumentation skills. Based on data analysis of written arguments produced by students about the problem presented, the average student is in a Level 1 coding scheme (above 60%). This indicates that there have been a cognitive process that has led to the ability to identify questions, facts, relevant knowledge, creative ideas, and formulate predictions. It can be concluded that the enrichment of argumentative skills are able reconstructstudent's higher order thinking skills. So the impilaction of this study is the teacher should enrich studen's argumentation skills in order to reconstruct their higher order thinking skill through a cognitive activity.

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