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Higher Order Thinking Skills Achievement for Biology Education Students in Case-Based Biochemistry Learning

Wiwi Wikanta
Corresponding author, Biology Education Department, Universitas Muhammadiyah of Surabaya, East Java, Indonesia, *wikanta@fkip.um-surabaya.ac.id*

Herawati Susilo
Biology Education Department, Universitas Negeri of Malang, East Java, Indonesia, *herawati.susilo.fmipa@um.ac.id*

The development of HOTS has become a new trend in the 21st century learning process. Many approaches and models are applied in the learning process to achieve HOTS, including case-based learning approaches. This study aims to reveal a description of the level of student HOTS achievement in Case-Based Biochemistry Learning which took place in the Even Semester of 2019/2020. This research is descriptive research. A sample of 24 people was taken from students of the Biology Education Department, Faculty of Teacher Training and Education, University of Muhammadiyah Surabaya. HOTS data, which includes the analyze, evaluate, and create skills, were collected using the documentation method. Data were analyzed descriptively and statistically. The results of this study, namely: (1) the average student HOTS score was 67.79 including the "High" category; (2) mastery of HOTS skills from the total score of test questions: (a) analyzing 68.82% on the organizing thinking process. (b) evaluating 61.51% on the examining thinking process. (c) creating 76.38% on the planning thinking process; and (3) based on the statistical test, the students' mean HOTS score was significantly higher than the expected value, which was > 65 ($\rho > 0.05$). The conclusion from the results of this study shows that the HOTS level of Biology Education Department students in new case-based Biochemistry learning reaches the high category at the lowest limit. Implementation of CBL to increase HOTS can be done even better by designing good cases and selecting the right type of CBL

Keywords: achievement, biochemistry, case-based learning, higher order, thinking skills

INTRODUCTION

Biochemistry is one of the compulsory subjects in the research of pure and applied science curriculum. Biochemistry is a branch of science that studies chemical processes in and related to living organisms, namely a laboratory-based science that unites biology and chemistry (Usman, 2017). Biochemistry is considered a difficult subject matter and less attractive to students (Kumari et al., 2016). Biochemistry learning, should not only

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achieve mastery of knowledge, but must also achieve more important results in the form of thinking skills, including higher-order thinking skills (Saputri et al., 2019). Higher order thinking skills (HOTS) needed in the 21st century (Miterianifa et al., 2021) in some lessons in schools are still not effective in instilling HOTS, due to many aspects, including the role of the teacher (Yen & Halili, 2015). In addition, subject matter and exam questions are still dominated by low-level thinking skills (Agustina et al., 2021; Black, 2020). Biochemistry learning in classrooms has used a variety of strategies, approaches, and models so that students achieve learning goals, such as Project-Based Learning (Baker et al., 2011); Problem-Based Learning (Djidu & Jailani, 2016) (Munawaroh, 2020); Meaningful learning (Anwar et al., 2018).

Recently, biochemistry learning has used a case-based learning approach, especially in the field of health and medical education (Sannathimmappa et al., 2019; (Sulistyoningrum & Lusiyana, 2018). Case-based biochemistry learning is used with the aim of shifting rote-based biochemistry learning that has been widely used by lecturers. The results of research that have been carried out show that the use of case-based learning (CBL) in teaching biochemistry can facilitate deep learning by increasing student engagement and interest (Kulak & Newton, 2014).

Biochemistry learning is not only a compulsory subject in health and medical education research programs. but has become a mandatory subject in the research of all biology research programs, including biology education research programs (Kurniawati & Jailani, 2020). The application of case-based learning in biochemistry learning in biology education research programs has not been widely revealed. Considering biochemistry as a difficult material, biochemistry learning tends to be done through lectures, questions and answers, and practicum (Pramiadi et al., 2006; (Periadnadi et al., 2017). Therefore, further research on case-based learning in biochemistry learning in biology education study programs needs to be carried out with a focus on the problem of how far the application of case-based learning in Biochemistry Learning can play a role in achieving HOTS for students of the Biology Education Study Program, Faculty of Teacher Training and Education, Muhammadiyah University of Surabaya, Indonesia? The formulation of the problem specifically, namely: (1) how is the level of student HOTS achievement?; (2) how is the HOTS level in each category and type of student's higher-order thinking process?; and (3) how effective is the application of CBL in Biochemistry Learning in achieving HOTS students of the Biology Education Department, University of Muhammadiyah Surabaya?

Based on the description above, the objectives of this research are: (1) to reveal a description of the student’s HOTS level achievement; (2) to assess the level of HOTS in each category and type of thinking process; and (3) to determine the effectiveness of the application of CBL in Biochemistry Learning in achieving HOTS for Biology Education students at Universitas Muhammadiyah of Surabaya?

Context and Review of Literature

Case-Based Learning

The use of the term case-based learning (CBL) in learning still confuses some teachers with regard to the term problem-based learning (PBL). There are teachers who say CBL is an approach or a learning method (Sannathimmappa et al., 2019). On the other hand, there are teachers who view CBL as the same as PBL as a learning model (Kulak & Newton, 2014). An overview of the differences between CBL and PBL in clinical case learning can be seen in the summary presented in Table 1.

Tabel 1
Comparison between PBL and CBL in clinical case teaching

No	Domain	PBL	CBL
1	Initial topic	Not known	Known
2	Beforehand Preparation	No	Some preparation
3	Facilitator's role	Provide limited direction	Provide direction
4	Data-seeking	Allowed	Not allowed
5	After session preparation	Applicable	Not applicable
6	Learning objectives	Identified during the session	Identified before the se

Source: Daher et al., (2017)

Based on Table 1 above, Daher and colleagues (2017) suggest that the similarities between PBL and CBL lie in the students' approach in raising the problems presented, the use of the same case for the next session, and the ability to ask questions, interact and discuss among the groups.

Cases in CBL act as media (Kulak & Newton, 2014). A case can often be presented as a narrative that resembles a real-life situation that provides clear context and a central character, specimen, or element, in which difficulties need to be resolved. The use case in CBL is different from the case in PBL. Cases in CBL are more structured, shorter and less complex. Meanwhile, the case for PBL is complex, an open-ended problem that was not previously known by students (Daher et al., 2017). A good case must be interesting, facilitate learning outcomes, integrate and apply information, and provide cognitive benefits in the form of increasing student involvement in the learning process (Kulak & Newton, 2014).

In addition to cases, the success of CBL in achieving learning outcomes is determined by the choice of the type of learning model (Kulak & Newton, 2014). Furthermore, Kulak and Newton (2014) suggest that a good CBL is determined based on the level of involvement of students and lecturers in case-based learning. For example, Lecture-based, directed, Interrupted, Jigsaw, and PBL, respectively, show the type of learning model in the CBL approach which has a higher level of training students' thinking skills in terms of: group work, self-directed, the role of lecturers in lecturing, complexity cases, and providing solutions. The success of implementing CBL depends on the lecturer in choosing the type of learning model (Daher et al., 2017).

Until now, the implementation of CBL has been carried out for various purposes. The application of CBL can be used as an approach in achieving concept retention, reasoning abilities; creating interest; encourage better understanding, active participation, and independent learning, and motivating learners to become lifelong learners (Newton et al., 2017). CBL is more effective in improving students' performance, learning outcomes and clinical reasoning and also has high acceptance among medical students (Sulistyoningrum & Lusiyana, 2018); CBL is an excellent educational tool to motivate and promote student learning. It enhances students' analytical thinking, clinical reasoning, conceptualization, and knowledge retention. It also benefits students in terms of their better examination preparation and performance (Sannathimmappa et al., 2019); case research-based learning enhances student engagement, and a significant and positive relationship between case-based learning and all four aspects of engagement, i.e. behavioral, emotional, cognitive and agentic engagement, was observed statistically (Raza et al., 2020); Large majority of students found that incorporation of CBL is an interesting approach to learn biochemistry Faculty found that CBL can be introduced for certain selective topics and felt that students will be more oriented towards the subjects(Agrawal & Verma, 2019).

The findings of the previous CBL research were interesting to be studied further in connection with the development of HOTS in Indonesia. The development of HOTS for students in learning was still not optimal and difficult to achieve. Efforts to strengthen the quality of learning and teaching are still being carried out in growing students' HOTS. Similar cases are still found in other countries, that the achievement of HOTS in students is still very varied. Engineering students from several universities in Malaysia show that the level of HOTS associated with learning styles is still at a moderate level (Yee et al., 2015). HOTS learning has its own challenges and needs attention, especially from educators. The teacher's role in instilling HOTS is another important aspect in teaching HOTS effectively (Yen & Halili, 2015). Schools need to design future professional development programs for Malaysian mathematics teachers to re-conceptualize HOTS and apply it in regular classrooms (Tajudin & Chinnappan, 2016).

Higher Order Thinking Skills

The term higher order thinking skills or often abbreviated HOTS in the learning process has long been known. Higher order thinking skills (HOTS) are a popular concept in American education (Watson, 2019). Education experts define and classify very diverse types of HOTS. King and colleagues (1998) in a book entitled: "Higher Order Thinking Skills: Definition, Teaching Strategies, Assessment" state that HOTS includes critical, logical, reflective, metacognitive, and creative thinking (King et al., 1998). Marzano and Kendall (2007) classify thinking skills into a New Taxonomy, namely Cognitive System, Metacognitive System, and Self-System Thinking (Marzano & Kendall, 2007). HOTS according to the P21 Learning Framework, are 21st Century skills known as 7-Cs skills, namely: (1) Critical thinking and problem solving. (2) Creativity and innovation. (3) Collaboration, teamwork, and leadership. (4) Cross-cultural understanding. (5) Communications, information, and media literacy. (6) Computing and ICT literacy; and (7) Career and learning self-reliance (Trilling & Fadel, 2009).

Brookhart (2010) classifies HOTS into seven skills, namely: analyzing, evaluating, creating, reasoning and logic, decision making, problem solving, and creative thinking (Brookhart, 2010). The type of HOTS that Brookhart found has been used to measure the level of HOTS based on subject matter and chemistry questions in textbooks used in high school (Agustina et al., 2021). Meanwhile, HOTS is based on a taxonomy of learning, which was made by Benjamin Bloom in his 2001 Revised edition of the book that HOTS is reflected by the top three levels of thinking process dimensions in Bloom's

Taxonomy: analyze, evaluate, and create (Anderson et al., 2001). In detail, the HOTS are based on the Revised Edition of Bloom's Taxonomy, as presented in Table 1 below.

Tabel 1
The cognitive process dimension

Categories & Cognitive Process	Alternative Name	Definition and Examples
4. Analyze – Break material into its constituent parts and determine how the parts relate to one another and to an overall structure or purpose		
4.1 DIFFERENTIATING	Discriminating, distinguishing, focusing, selecting	Distinguishing relevant from irrelevant parts or important from unimportant parts of presented material (e.g., Distinguish between relevant and irrelevant nurnbers in a mathematical word problem)
4.2 ORGANIZING	Finding coherence, intergrating, outlining, parsing, structuring	Determining how elements fit or function within a structure (e.g.1 Structure evidence in a historical description into evidence for and against a particular historical explanation)
4.3 ATTAIBUTING	Deconstructing	Determine a point of view, bias, values, or intent underlying presented material (e.g., Determine the point of view of the author of an essay in terms of his or her political perspective)
5. EVALUATE – Make judgments based on criteria and standards		
5.1 CHECKING	Coordinating, detecting, monitoring, testing	Detecting inconsistencies or fallacies within a process or product; determining whether a process or product has intemal consistency; detecting the effectiveness of a procedure as it is being implemented (e.g., Determine if a scientist's conclusions follow from observed data)
5.2 CRITIQUING	Judging	Detecting inconsistencies between a product and external criteria, determining whether a product has external consistency; detecting the appropriateness of a procedure for a given problem (e.g., Judge which of two methods is the best way to solve a given problem)
6. CREATE – Put elements together to form coherent or functional whole; reorganize elements into a new pattern or structure		
6.1 GENERATING	Hypothesizing	Coming up with alternative hypotheses based on criteria (e.g., Generate hypotheses to account for an observed phenomenon)
6.2 PLANNING	Designing	Devising a procedure for accomplishing some task (e.g., Plan a research paper on a given historical topic)
6.3 PRODUCING	Constructing	Inventing a product (e.g., Build habitats for a specific purpose)

METHOD

Research Design

This research is a descriptive study with case studies (Ary et al., 2010); (Suharta & Suarjana, 2018; Soeharto & Rosmaiyadi, 2018). The research was conducted on the results of the Case-based Biochemistry Learning process, which took place in the Even

Semester of 2019/2020 at the University of Muhammadiyah Surabaya. A sample of 24 students was obtained from the entire population using the convenience sampling method (Ary et al., 2010). The research procedure includes the following steps: (1) collection of document archives, which include: student worksheets, final exam test questions, and a list of final scores; (2) tabulate the data according to the type of document; (3) analyzing the data descriptively and statistically.

Data Collection and Analysis

The data in this study are students' HOTS referring to the revised edition of Bloom's learning taxonomy, which includes skills: analyzing, evaluating, and creating (Anderson et al., 2001). In detail, HOTS is translated into cognitive processes. Cognitive processes in the analysis category include: distinguishing, organizing, and giving position. Cognitive processes in the evaluating category include: cognitive processes of examining, and critiquing. Meanwhile, cognitive processes in the category of creating include: planning and producing. Research data were collected by the documentation method, namely data obtained from sources in the form of archives (Drew et al., 2008). The documents in this study were student worksheets, test questions, and a list of grades obtained from the lecturer of the biochemistry course. Student worksheet documents are used to collect data about the description of teaching materials used by lecturers during the case-based learning process. Documents about the test were used to collect data about the types of higher order thinking skills being measured. Meanwhile, the student score list document is used to collect student HOTS scores. The students' HOTS scores are expressed quantitatively in the form of a scale value of 100. The data were analyzed descriptively and statistically (Nurizzati, 2016).

a) Descriptive Data Analysis

Analysis was carried out on documents, namely: (1) student worksheets, (2) test questions, and (3) student scores in archive form (Drew et al., 2008). Analyzed student worksheet documents and test questions to find aspects of case-based learning which include: (1) case examples; (2) learning models, and (3) HOTS achieved. Meanwhile, the value analysis is to find the HOTS achievement data which includes: (1) the level of the student's HOTS category; (2) students' HOTS levels are in each category; (3) the level of mastery of students' HOTS on aspects of cognitive processes. Student score data are grouped into the HOTS level, which consists of 5 categories (Erfan & Ratu, 2018; Suharta & Suarjana, 2018), namely: (1) very low; (2) low; (3) moderate, (4) high, and (5) very high, which is determined based on the provisions as presented in Table 2.

Table 2
Range of HOTS Level Values

NO	Range of Value	Category HOTS Level
1	$85 < X \leq 100$	Very High
2	$65 < X \leq 85$	High
3	$45 < X \leq 65$	Moderate
4	$25 < X \leq 45$	Low
5	$0 < X \leq 25$	Very Low

(Source adapted from: Erfan & Ratu (2018; Suharta & Suarjana (2018)

Furthermore, the data were analyzed to determine the percentage of students at each HOTS level. The percentage of students' HOTS level was determined by calculating the number of students who were in the range of values, as Table 1, using the formula below (Heong et al., 2012; Husamah et al., 2018; Suharta & Suarjana, 2018).

$$Precentage\ (\%) = \frac{Number\ of\ students\ in\ the\ grade\ range}{Total\ number\ of\ students} x\ 100\%$$

b) Statistical Data Analysis

This statistical analysis was used to test the effectiveness of the application of case-based Biochemistry learning in achieving student HOTS. The descriptive hypothesis was that the HOTS level of students who had participated in case-based biochemistry learning had a value of > 65 from the ideal value of 100. This meant that the student's score was equivalent to the HOTS level in the "High Category". Data analysis used the statistical method T-test for one sample at an error rate of 5% ($\alpha = 0.05$) (Sugiyono, 2014). The one-sample T-test in this research compared the average test score with the expected value, which was > 65 (Harjono et al., 2013; Nurizzati, 2016). The value of 65 was a lower limit value that is in the range of values with the "High" HOTS category (Table 6). The hypothesis in this research was formulated as follows:

1) Ho: 65. Ho was accepted, if < 0.05. This meant that the average student score on the test results was at least equal to or less than 65 (µ 65).

2) Ha: > 65. Ha was accepted, if > 0.05. This meant that the average student score on the test results was greater than 65 ($\mu > 65$). Statistical analysis was performed by using SPSS version 23 for Windows.

FINDINGS

Description of Case-Based Learning Documents

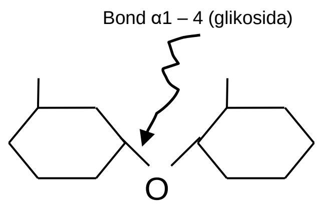
Research with the aim of revealing students' HOTS achievement levels in Case-Based Biochemistry Learning has been carried out with several findings, as described below.

One of the documents that became the source of data in this research was the student worksheet. There were approximately 10 student worksheet documents used in this research, which contained cases according to lecture topics which included understanding concepts, chemical properties and structures, and metabolism of biomolecules in the body. Examples of cases in the student worksheet in biochemistry learning of the Biology Education Research Program, FKIP Universitas Muhammadiyah of Surabaya are presented in Table 3.

Table 3
Case findings and HOTS in Whorksheet documents for case-based biochemistry learning case

Examples Case	Findings
Case-1: Corona virus (CoV) is a large family of viruses which can infect birds and mammals, including humans. According to the World Health Organization (WHO), this virus causes illnesses ranging from mild flu to more severe respiratory infections. Corona viruses are responsible for several outbreaks around the world, including the 2002-2003 Severe Acute Respiratory Syndrome (SARS) pandemic and the Middle East Respiratory Syndrome (MERS) outbreak in South Korea in 2015. Recently, a new coronavirus emerged and is known as as COVID-19 triggered an outbreak in China in December 2019 and spread in various countries so that WHO declared it a global pandemic. Research Guide and Biochemistry Questions: 1. In groups, look for articles about the Corona Virus to complete information on Covid-19. Based on the cases above and reviewing the articles collected: a. Write down the chemical compounds that make up CoV found! b. Group these chemical compounds into groups: (1) carbohydrates, (2) proteins, (3) lipids, (4) nucleic acids. c. What do you think about the Corona virus in Covid-19 cases based on biochemistry? 2. Prepare materials in PPT form for presentation. 3. PPT is collected 1 day before the next lecture via email: wikantabio92@gmail.com,	Student worksheet has included cases in the form of structured narratives related to the context of life. Student worksheet contains the type of learning that guides or trains higher-order thinking skills collaboratively in solving cases Student worksheet contains biochemical questions that are relevant to learning outcomes through the thinking process of higher-order thinking skills HOTS in Case-1: analyze (find chemical compounds in CoV), evaluate (classify chemical compounds;), and create (conclude, plan and make presentation products)
Case-2: Many people in everyday life know fat than lipid. Talking about fat, surely people will remember oil and cholesterol. Rarely do people know fat as Triacylglycerol / triglycerides (TG). Look at the pictures of various examples of compounds below (attached). Research Guide and Biochemistry Questions: Based on the examples of lipid compounds above, discuss the following problems: a. Why are the examples of chemical compounds above called LIPIDs? Explain! b. What are the lipids found in living things, animals or plants? Explain! c. What are the properties of the lipids that make up the body of living things? d. If it should be grouped into how many groups of lipid types above? Explain, what is the basis for grouping it? e. What are the functions of lipids in living organisms?	HOTS in Case-2: analyze (distinguish and classify Lipids); evaluate (match Lipid criteria, decide on the basis of grouping)
Case-3: Recently, more and more people suffer from degenerative diseases, such as hypertension, stroke, dyslipidemia, and diabetes mellitus (DM). The causative factors, including lifestyle in consuming food. Diabetes Mellitus has to do with carbohydrate metabolism. Research Guide and Biochemistry Questions Using additional literature from various sources, both offline and online, discuss with the members of each group the following questions: 1. What is DM disease? Explain! 2. Why do people have DM? Explain! 3. How is DM related to carbohydrate metabolism? Use the picture of the metabolism chart provided below to help you explain!	HOTS in Case-3: analyze (give perspective); evaluate (determine, decide on DM)
Case-4: In the past, people only recognized back and joint pain as gout or rheumatism. Gout (gout) later known due to increased uric acid in the blood and urine. Lately, people are afraid of what is called gout. Every food consumption will always be associated with uric acid. This is not an exaggeration, because Pak Ahmad's experience, who once suffered from gout, told how torturous it was to endure pain due to high uric acid in the body. Research Guide and Biochemistry Questions Discuss with the group members each of the following problems: a. Nucleic acids consist of DNA and RNA, what are the components of nucleic acids? b. How are DNA and RNA formed in the animal body? c. How are DNA and RNA broken down in the body? d. What are the end products of the breakdown of nucleic acids (purines and pyrimidines)? e. Why are people afraid of gout? What are the effects of high uric acid in the blood? f. Is it true that food can increase uric acid levels in the body? Explain the metabolism of nucleic acids (purines)! g. Plan and implement a solidarity project to tackle gout in the community!	• HOTS in Case-4: analyze (differentiate components of RNA/DNA, regulate metabolic processes), evaluate (check metabolic results), create (predict, plan, make products)

Table 4
HOTS findings on exam questions

No	Items	Score	Operational Verb	Findings of HOTS
1	1 The Covid-19 pandemic that is currently endemic is caused by the Corona Virus. What do you think, is the Corona Virus a living thing? Explain! (Score 5) 5 Explaining Including HOTS analysis: explanation of the question how which requires thinking skills relates something	5	Explaining	Including HOTS Analyzing: starting from thinking skills to a set of available data to choose the appropriate one.
2	Living things are chemically different from non-living things. a. Name 5 kinds of chemical compounds that make up the body of living things that distinguish them from non-living things! (Score 5) b. What are the chemical properties of these living things? (Score 10)	15	Distinguishing, explaining	Mentioning Including HOTS Analyzing: starting from thinking to distinguish from a set of available data to choose the appropriate one. . • Includes HOTS Evaluating: explanation of the results of critiquing
3	The bodies of living things are made up of 80% water. The body fluids of living things affect the pH of body fluids. a. Explain, how is the role of water in regulating the body's pH? (Score 5) b. Complete your answer with a chemical reaction! (SCORING 10)	15	Explains. Creating	• Including HOTS Analyzing: linking conditions with functions • Including HOTS Creating: Thinking skills to produce a product
4	Consider the chemical structure of one of the examples of carbohydrates below:  Maltosa a. Included in the carbohydrate group what are the examples of carbohydrates above? Why? (Score 4): b. What is the smallest unit (monosaccharide) that makes up the carbohydrates above? (Score 5): c. Describe its chemical properties in terms of: (1) the number of carbon atoms; (2) functional groups; (3) enantiomers. (Score 6): Show with a picture the chemical	30	Grouping, determining, explaining, showing,	• Including HOTS Evaluating: thinking skills checking to match or classifying • Including HOTS Analyzing: connecting the constituent units to the complete form of a building • Including HOTS Evaluating: peeling or describing based on units-constituent units • Including HOTS creating: compiling a statement based on the facts encountered • Evaluating: checking compatibility with criteria

No	Items	Score	Operational Verb	Findings of HOTS
	structure, if the carbohydrate example above becomes a polysaccharide! What is the name of the polysaccharide formed? (Score 5): d. Why is the glycosidic bond calling a bond? How strong is the bond? (Score 10):			
5	Lipids are an important part of the body of living things. Apart from being a constituent of cell membranes, lipids also make up many important body parts. a. Is cholesterol a lipid? Give a reason! (Score 5): b. Why do lipids exist as liquids and solids at room temperature? Complete the answers with examples! (Score 5): c. How are simple lipids (triglycerides) formed? (Score 5): d. Write down the chemical reaction for the formation of these simple lipids and give a description of each part of the chemical compound involved! (Score 10): e. Why are lipids that make up cell membranes called amphipathic? (Score 5): f. What are the benefits for living things? (Score 5):	35	Give reasons, differentiate, arrange, write, explain relationships, explain advantages	• Include HOTS Evaluate: check/check based on certain criteria • Include HOTS Analyze: differentiate based on certain criteria • Include HOTS Analyze: organize units into Unity • Including HOTS Creating: planning a product to be made • Including HOTS Evaluating: checking/checking according to criteria • Including HOTS Evaluating: connecting facts with certain conditions
Total Score		100		

Description of Student HOTS Scores

The HOTS scores of 24 students from the final semester test results were held on even semester year 2019/2020 in the form of a summary is presented in Table 5.

Table 5
Student HOTS score

Descriptive Statistics	Score
Samples Size	24
Maximum Score	94
Minimum Score	38
Average	67,79
Deviation Standard	13,25

Descriptive Data Analysis

In general, the average value of students is 24 people from the end-semester test results in case-based biochemistry learning was obtained at 67.79 (Table 5). The average value of these students based on the HOTS level grouping (Table 6), is in the "High" category.

Furthermore, the data were analyzed to obtain an overview of the percentage of students at each level of HOTS. The results of the student HOTS level analysis are presented in Table 6.

Table 6
Percentage of students at the HOTS level

NO	Range of Values	HOTS Level	f	Percentage (%)
1	85 < X ≤ 100	Very High	2	8,33
2	65 < X ≤ 85	High	12	50,00
3	45 < X ≤ 65	Moderate	9	37,50
4	25 < X ≤ 45	Low	1	4,17
5	0 < X ≤ 25	Very Low	0	0,00
Total			24	100

Research data based on Table 6, showed that the percentage of students was at the high category HOTS level of 50.00%. Meanwhile, the remaining percentage of students at the very high HOTS level was 8.33%; the HOTS level was sufficient as much as 37.50%, and the low HOTS level was only 4.17%. There were no students with very low HOTS levels.

The description of the HOTS level of students seen from the HOTS Domain based on Bloom's Taxonomy grouping was presented in the graph in Figure 1.

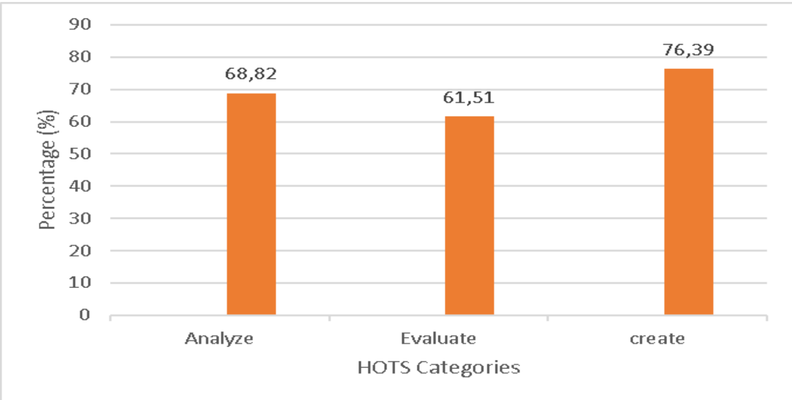


Figure 1
HOTS level in each category

HOTS level in each category

The HOTS level of students in each category, as presented in Figure 1, showed that students had the highest HOTS in the creative category with mastery of skills of 76.38%. The HOTS level in the analysis category with mastery of skills was 68.82%. Meanwhile, the lowest HOTS was in the evaluation category with a mastery of skills score of 61.51%. More detailed research data about students' HOTS levels seen from the types of cognitive processes from each category were shown in the graph in Figure 2.

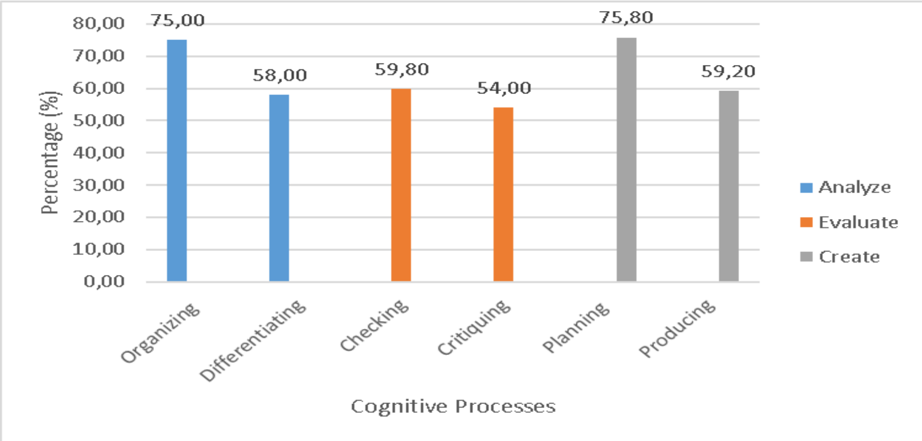


Figure 2
Students' HOTS levels in the types of cognitive processes in each HOTS category

Based on the graphs in Figure 2, students' HOTS levels in the organizing thinking process and planning were the highest level of HOTS with mastery of skills, namely 75% organizing and 75.80% planning. While the lowest level of skill mastery was in the critical thinking process of 54%.

Descriptive Statistical Data Analysis

The results of the Normality Test using the One-Sample Kolmogorov-Smirnov Test (Sugiyono, 2014) show that the data are normally distributed ($\alpha > 0.05$). The results of the statistical data analysis using the One sample t-test processed with the SPSS Version 23 application (Nurizzati, 2016; Harjono et al., 2013) are presented in Table 6.

Table 6
Result of One-Sample T-Test

Variable	Test Value = 65					
				Mean	95% Confidence Interval of the Difference	
	T	df	Sig. (2-tailed)	Difference	Lower	Upper
Value	1.032	23	.313	2.792	-2.80	8.39

Based on Table 6, the test significant values were obtained for 0.313, meaning the value-ρ > 0.05, so that Ha was accepted. That was, statistically the average score of student test results in Case-based Biochemistry Learning was greater than 65 ($\mu > 65$). This proved that the HOTS level of students in Case-based Biochemistry learning is in the "high" category.

DISCUSSION

The findings of this research, based on document review indicated that the case as one of the characteristics of case-based learning in biochemistry learning had been prepared by the lecturer. Of course, the case determination had been adjusted to the previously prepared lesson plan (Patil et al., 2017). Next, students completed the given case with a research guide according to the student worksheet. Based on the 4 cases in the student worksheet above, the researchers got an idea of how the understanding of biochemical concepts that was built by students through a case-based biochemistry learning process. The students were actively involved in solving problems presented in the form of cases that exist in everyday life. Student involvement was revealed from research guides, such as the command to discuss, seek, and prepare. In the worksheet above, a research guide was found to train thinking processes in higher order thinking skills, such as analysis, evaluation and collaborative creation.

In fact, case-based learning was an example of a meaningful learning approach (Anwar et al., 2018; Cedere et al., 2020; Fan et al., 2015; Kean & Kwe, 2014; Trifone, 2017). The students engaged in knowledge content development, and learn increasingly important 21st Century skills, such as the ability to work in teams, solve complex problems, and apply knowledge acquisition through one lesson or task to another (Barron & Darling-Hammond, 2008; Miterianifa et al., 2021).

Biochemical knowledge had different levels ranging from low levels to higher dimensions, namely factual, conceptual, and procedural (Anderson et al., 2001). Metabolism was a more complex knowledge; besides containing factual and conceptual knowledge, it also contained procedural knowledge. The students needed to think more deeply and critically in understanding metabolic processes. Case-based biochemistry learning can bridge the difficulties of students in understanding higher knowledge by being given an overview of initial knowledge in the form of cases found or known in everyday life. Case-based biochemistry learning is more interesting and motivates student learning (Sannathimmappa et al., 2019). High-level skills that were trained through the cases above, include: Analysis of differentiating and organizing thinking processes; evaluation of the thinking process of checking, and critiquing; creativity in planning and producing thought processes.

The cases contained in the student worksheet on Biochemistry learning in this research were interesting and showed problems in everyday life. Cases as media in the CBL need to be well prepared. A good case according to Kulak and Newton (2014) has cognitive characteristics and advantages. Characteristics of a good case, namely, presenting an interesting story, interesting or controversial theme so as to encourage discussion of scientific concepts. cases relevant to student life. Meanwhile, the cognitive advantage gained, namely promoting active involvement in the learning process; students cannot rely solely on memorizing facts to solve cases (Kulak & Newton, 2014). Step by step development of a good case in detail (Kulak & Newton, 2014) as follows: (1) defining learning objectives; (2) selecting CBL type and assessment method to fit course context; (3) selecting setting and character, review scientific evidence on topic and textbook (if one is used in course); (4) writing the vignette based on current evidence, develop a real-life context; (5) writing learning issue, select supporting references, table, etc, develop answer key; (6) testing the case; feedback from other instructor and/or target student sample; (7) revising the case based on feedback; and (8) developing variations on the case to suit different groups or time limits. The students in CBL were usually given articles and learning resources on the topic and groups were then assigned to present the material. In contrast, in PBL students were required to use additional resources either during or after the PBL session (Daher et al., 2017).

In the student worksheet, the types of learning strategies in solving cases have been stated, although the types of design in the SW have not been clearly described, and the details of the steps are complete. Five kinds of CBL can be applied in case-based learning according to their characteristics, including: (1) lecture-based; (2) Directed; (3) Interrupted; (4) Jigsaw; dan, (5) PBL (Kulak & Newton, 2014). The type of learning model in the SW document has shown student involvement during the learning process. The kind of learning model chosen in the CBL approach describes student involvement, the complexity of the cases to be solved, and the learning outcomes that must be achieved. The type of CBL learning model found in Biochemistry learning in this study is a type of direct learning model (directed models), namely in the form of mixed lectures, group work plus lectures or other pedagogies, supporting materials, such as pictures, tables, ppt, videos and others. Other materials are provided, special questions accompanying cases and closed answers; the instructor facilitates discussion of common solutions with the whole class. Suitable for introductory courses, prior knowledge is given in lectures (Kulak & Newton, 2014). This type of CBL directed model is also widely used in other lessons, such as lectures on Microbiology and Immunology at the College of Medicine and Health Sciences (Sannathimmappa et al., 2019); information ethics course at Midwestern university (Dow et al., 2015); lectures on tropical infectious diseases at UII (Sulistyoningrum & Lusiyana, 2018); clinical biochemistry study at the Department of Biochemistry, Indira Gandhi Institute of Medical Sciences Patna, India (Kumari et al., 2016).

Meanwhile, there was a CBL type with a higher learning model, where groups were given complex cases without many clues; no supporting information was provided; students asked their own questions to solve; solutions were open-ended and depend on what each group decides to focus on; instructors are trained in mediation to facilitate discussion at the group level (Kulak & Newton, 2014). The model used in this type of CBL was a problem-based learning model(Dong & Zeng, 2017). Another thing that needed to be considered in order for HOTS learning to be effective, teachers must realize that the effectiveness of HOTS teaching can only be realized when the traditional view of transmitting information becomes less important to a more constructivist view that provides active student learning that is useful and meaningful in the learning process (Yen & Halili, 2015). Biochemistry educators have an obligation to equip students with skills that can enable them to be innovative and independent. The next generation of biochemistry and molecular biology students should be taught proficiency in scientific and technological literacy, the importance of scientific discourse, and the skills needed for 21st century problem solvers (Black, 2020).

Based on the average student HOTS score of 67.79, it is at the "High" level. That is, the case-based learning approach in this study has shown significant HOTS results. However, the average HOTS score achieved by students is still at its lowest limit. The implementation of CBL in biochemistry courses has motivated students to learn and trained students to use higher order thinking skills. This is also shown from the results of previous studies, such as CBL can increase student interest and satisfaction (Agrawal & Verma, 2019); CBL is more effective in improved students' performance, learning outcomes and clinical reasoning (Sulistyoningrum & Lusiyana, 2018); CBL enhances students' analytical thinking, clinical reasoning, conceptualization, and knowledge retention (Sannathimmappa et al., 2019). The achievement of the HOTS level of students in Case-based Biochemistry Learning has been proven by statistical tests using the One Sample t-Test method at a 95% confidence level ($\alpha = 0.05$). The results prove that the HOTS level of students in this case-based biochemistry learning, significantly ($\rho > 0.05$) was better than expected; namely, the student's HOTS score was greater than 65 ($\mu > 65$). Of course, this result still needs to be improved with a higher HOTS level. However, the application of CBL is not without its weaknesses. One of the weaknesses of CBL is that it takes a long time (Kumari et al., 2016).

Meanwhile, from the results of this research, it was also found that the distribution of students at the HOTS level, as the research data in Table 4, showed that most students, amounting to 58.33%, were at the high HOTS level. This meant that more than half of the students already had high HOTS. It can be said that case-based biochemistry learning has been effective in achieving HOTS. The effectiveness of the results of this research was supported by the results of previous researches that 85% of students and 80% of teachers agree that CBL helped in deep learning and critical thinking; 84% of students and 73% of teachers feel that CBL made the subjects interesting with good content retention and reasoning skills for their future medical (Patil et al., 2017). The effectiveness of case-based learning outcomes was also determined by student responses. Where, students differ in how they respond to the learning activities presented by their instructors, because there were some students who had tried harder, while others responded in a very relaxed way (Raza et al., 2020). The skill of getting ideas was included in HOTS. Difficulty in generating ideas was a key factor affecting the completion of student assignments (Heong et al., 2012).

The achievement of the HOTS level of students in case-based Biochemistry learning in terms of mastery of thinking process skills was already high, as shown by the data (Figure 1). In addition, the achievement of students' HOTS levels in terms of the thinking process obtained data (Figure 2) that the organizing and planning thought processes were the highest HOTS levels. While the lowest level of skill mastery was in the critical thinking process. The difference in achievement in each HOTS category was in accordance with the complexity of each category. The HOTS grouping as revised Bloom's Taxonomy included analysis, evaluation, and creation skills that showed the complexity of each thinking skill. The six categories of cognitive process dimensions, namely remembering, understanding, applying, analyzing, evaluating, and making, are divided into low-level thinking skills (LOTS) and HOTS (Watson, 2019). The order underlying the dimensions of cognitive processes was assumed to be the complexity of cognitive processes; namely, cognitively understanding is believed to be more complex than remembering; applying was believed to be more complex than understanding, and so on (Anderson et al., 2001). The case approach to learning Biochemistry and molecular biology as medical disciplines, a basic discipline, is an ideal choice, because the theories are abstract, difficult to understand, and many students are not enthusiastic about learning (Dong & Zeng, 2017; Patil et al., 2017). Biochemistry educators have an obligation to equip students with skills that will enable them to be innovative and independent. The next generation of biochemistry and molecular biology students should be taught proficiency in scientific and technological literacy, the importance of scientific discourse, and the skills needed for 21st century problem solvers (Black, 2020). Not only in Biochemistry learning, HOTS needs to be trained. but in almost all subjects, the importance of HOTS in preparing for the 21st Century generation, including other science lessons(Barak & Shakhman, 2008).

CONCLUSION

The results of this study can be concluded that the implementation of CBL in biochemistry learning has trained HOTS students of the Biology Education Study Program, University of Muhammadiyah Surabaya, with high level categories. The results of this study are supported by several findings, including: (1) the level of student HOTS achievement is in the High category with an average score of 67.79; (2) the worksheet used contains interesting, contextual cases, and can facilitate students using higher-order thinking skills, namely analyzing, synthesizing, and creating; (3) students are involved in learning actively and collaboratively; (4) the CBL approach has changed the role of lecturers from transferring knowledge to facilitating more constructive and meaningful active student learning.

Further research needs to be done to achieve a higher level of HOTS, namely: (1) compiling cases with good characteristics and impacting the benefits of thinking; (3) implementing case-based learning by choosing the type of CBL that is in accordance with the specified learning outcomes; (4) research on the application of CBL with experimental methods and inferential data analysis; (5) using a reliable and valid HOTS measurement instrument

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