**The PROFILE OF STUDENT LEARNING DIFFICULTIES IN BIOCHEMICAL COURSES**

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Received: xxxxxx; Accepted: xxxxxx; Published: xxxxxxx

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**Abstract**

Biochemistry studies the chemical composition, structure of substances and their transformation in the body of living things. Biochemical materials are abstract and difficult to study. This study aims to get an overview of students' learning difficulties in studying biochemistry. The study used a descriptive method. The research subjects were 17 students of Biology Education at one of the universities of West Sumatra. The research instrument consists of a questionnaire of student opinions on learning difficulties and a test of mastery of concepts. The data were analyzed qualitatively using percentage techniques. It was found that 26.47% of students had difficulties in molecular structure material, 58.82% in metabolic pathway material, and 14.71% in term material in biochemistry. Overall, students have difficulty in learning biochemical concepts as shown by a lecture achievement score of 0.51. Of the 17 students, there were only 4 students who scored in the difficult range, and the other students were in the difficult range. In general, students learn biochemistry by listening to lecturers' explanations and discussions with colleagues. Students think learning biochemistry is more meaningful through practicum activities. Learning resources used by students generally come from internet data, lecturer explanations and biochemistry books.

Keywords: Biochemistry, learning difficulty

DOI: <http://dx.doi.org/10.15575/jtk.xxx.xxx>

1. **Introduction**

*Biochemistry is a science that studies the chemical composition of living things, the structure of their substance and their transformation in the body of living things or commonly known as metabolism (Butnariu et al., 2018). Biochemistry material generally includes an introduction to biochemistry, biomolecules, enzymes, metabolism, gene expression and replication (Voet, Voet, &; Pratt, 2016). Rodwell et al., (2018) discuss biochemical material into several discussions, including 1) the structure and function of proteins and enzymes, 2) kinetics, mechanisms, regulations, and the role of enzyme metal transitions, 3) bioenergetics, 4) carbohydrate, lipid, protein and amino acid metabolism, 5) structure, function and replication of macromolecules, 6) biochemistry of extracellular and intracellular communication. Also discussed is the analysis of chemical composition in the body, the complexity of substance changes in living things, and investigating vital chemical processes (Butnariu, Petrescu, &; Ioan, 2018). Perumcheril (2017) explains that biochemistry discusses amino acids and proteins, carbohydrates, fats, molecular genetics, heme and hemoglobin metabolism, biological oxidation and the Krebs cycle. In a more concise discussion, biochemistry discusses amino acids and proteins, lipids, carbohydrates and nucleic acids (Żymańczyk- Duda et al., 2016).*

*Some schools and colleges also include biochemistry as a course. One of the competency standards in biochemistry courses is so that students have knowledge related to biochemical reactions that occur in the body's metabolism and are able to develop their applications in everyday life with material that includes carbohydrate, protein, lipid, vitamin, mineral and so on (Wijayanti &; Lestari, 2016). Biochemical studies can also include the chemical makeup of cells, the nature of chemical reaction compounds that occur in cells, and the application of chemical principles in understanding biology (Wahyuni, 2019). Each learning resource in the form of textbooks, dictates, and articles on biochemistry has a material order that is different from each other but has the main component elements of biochemical material, namely the structure and function of biomolecular and metabolic pathways. The biochemistry course at the Biology Education Study Program is a course that contains the structure and function of cells, carbohydrates, proteins, fats, nucleic acids, enzymology, biological oxidation and biochemical energy, the process of anabolism and catabolism of carbohydrates, fats, proteins. It can be said that biochemistry courses equip students to be able to understand the material structure of living things and the physiology of living things. Therefore, biochemistry is one of the interdisciplinary courses that is important to be taught to prospective students of science, biology, and chemistry.*

*Biochemistry lectures have been carried out on an active student basis. Face-to-face learning in class is also attended by students enthusiastically and earnestly. Learning is also assisted by practicum activities and utilizing information technology as learning should take place in the era of the industrial revolution 4.0. Learning that has been pursued in such a way does not seem to be able to provide good results as seen from student learning outcomes both through quizzes and midterm exams for students who take biochemistry courses in the 2022/2023 academic year. Low learning outcomes are one indication of learning difficulties. (Rizki, Nugraha, Saleh, 2017). Wahyuni (2019) strengthens that students who have learning difficulties are proven by low summative exam results.*

*The gap that occurs between the efforts that have been made in the learning process and student learning outcomes in biochemistry courses encourages further studies of the problems that occur. Problems that occur with students who take biochemistry courses can be classified as learning difficulties. Learning difficulties are a condition in learning characterized by certain obstacles to achieving learning outcomes (Cahyono, 2019). Learning difficulties can also be interpreted as a psychological disorder of a learner who has perfect physique but has difficulty accepting or capturing learning well (Utami, 2019). Learning difficulties can be further studied through learning difficulty diagnosis activities. Diagnosis of learning difficulties is all efforts made to find learning difficulties, determine the types of learning difficulties experienced, the characteristics of learning difficulties, learn about the factors that cause learning difficulties and know ways to prevent and overcome learning difficulties (Ismail, 2016). Diagnosis of student learning difficulties can be done by conducting diagnostic tests by test or non-test, namely through interviews, observations and so on.*

*The diagnosis of biochemical learning difficulties has been made by Halmo et al., (2018) revealed that learning difficulties in biochemistry can occur in amino acid materials and noncovalent interaction mechanisms. Widyaningrum &; Wijayanti (2019) stated that students have not been able to carry out biochemistry practicum systematically, where students should be trained in biochemistry and practicum courses through practicum. Rahmatan (2016) analyzes aspects of biochemical material that are difficult for students to understand. It is stated that the concept that is difficult to understand is about carbohydrate metabolism which contains abstract concepts and concepts that state processes, so to help students learn it, computer-based biochemistry learning was developed with drill and practice models packaged in software that can measure students' mastery of concepts and creative thinking skills. The reason many students have difficulty learning biochemistry is solid biochemistry material but lecture time is limited and students prefer electronic media in learning the material (Munawaroh et al., 2019), limited characteristics of material and teaching materials (Wahyuni, 2019), many concepts that must be learned, concepts that are not relevant to student life and to understand biochemical concepts higher order thinking skills are needed (Usman, 2019). Biochemistry is a subject that is considered difficult also expressed by Lismaya (2017), Bukhari et al., (2019), and Usman (2019). Even Perumcheril (2017) reveals biochemistry is a boring lesson.*

*Based on the presentation of previous research, it is necessary to conduct an analysis of the difficulty of learning biochemistry in students of the Biology Education Study Program. This research needs to be carried out as part of an effort to evaluate the learning difficulties of student biochemistry courses. This research can also serve as a material for need analysis to overcome student learning difficulties. Furthermore, this study aims to reveal student learning difficulties and to help students find solutions in the learning process and learning biochemistry courses, especially for students of the Biology Education Study Program. Various efforts to improve the learning and learning process from the results of evaluation and need analysis are expected to be carried out and realized in accordance with student characteristics, the condition of learning facilities and infrastructure, in accordance with the demands of the curriculum as prospective teachers and student needs for biochemistry courses as a basic provision for studying further courses.*

1. **Research Method**

This study was a descriptive study using Midterm Exam test results and questionnaires. The population in this study is students of the Biology Education Study Program at a University in West Sumatra who are taking biochemistry courses. The participants in this study were 17 students of the class of 2021/2022 who took the Biochemistry Course and were selected based on purposive sampling techniques. The study was conducted in April 2023.

Midterm Exam test data is collected and analyzed per question item, where each question has indicators according to predetermined learning outcomes. To see the difficulties experienced by students on each of these questions, the level of difficulty experienced by students is interpreted according to the following table:

**Table 1.** Range of interpretation of learning difficulties

|  |  |
| --- | --- |
| Range | Interpretation |
| 0.00-0.29 | Very difficult |
| 0.30-0.49 | Difficult |
| 0.50-0.69 | Quite Difficult |
| 0.70-0.89 | easy |
| 0.90-1.00 | Very Easy |

Source. Goldberg, 2020

Data was also collected using questionnaires. The questionnaire contains open-ended questions with indicators (1) student learning resources; (2) the way students learn; (3) the form of learning expected by students, and (4) students' difficulties in learning biochemical materials. Each indicator contains one question item. The data that have been obtained are analyzed qualitatively using percentage techniques.

1. **Result and Discussion**

Overall, students have difficulty in learning biochemical concepts as shown by a lecture achievement score of 0.51. Of the 17 students, there were only 4 students who scored in the difficult range, and the other students were in the difficult range.

Based on the learning difficulty test conducted on students who are taking Biochemistry courses, the following data were obtained:

**Figure 1. Interpretation of Student Learning Difficulties Based on Test Results**

The research was conducted by distributing questionnaire questionnaires with questions that can be answered openly by students. The results of the questionnaire analysis can be seen in the following table.

**Table 2. Results of Analysis of the Difficulty of Biochemistry Lecture Material**

|  |  |  |
| --- | --- | --- |
| **No.** | **Materi** | **Persentase (%)** |
| 1. | Metabolic Pathways | 58,82 |
| 2. | Molecular Structur | 26,47 |
| 3. | Terms in Biochemistry | 14,71 |

Based on the data from the analysis in Table 2, it can be seen that in general there are three categories of student difficulties related to biochemical materials, namely molecular structure, metabolic pathways and terms in biochemistry. The highest difficulty is in the material of metabolic pathways, which is as much as 58.82%. This is in accordance with what is shown in Figure 1, the Metabolic Pathway test students are asked to explain the function of each biomolecule in the metabolic pathway, the average student can only mention what is included in the biomolecule, students cannot analyze how each of these biomolecules performs their functions after being in the metabolic pathway, so from the interpretation of student learning difficulties based on table 1, The difficulty of students is in the range of very difficult and very difficult in the material of metabolic pathways. The molecular structure is also described when asking students to show how the protein denaturation process occurs and what causes the denaturation. Students have not been able to describe how protein structures are denatured, for example when caused by the heat of what molecules are released when denaturation occurs. When the presence of heavy metals that affect proteins, how specific structures are released from the protein, most students cannot describe their structure, so the interpretation of student learning difficulties if the percentage of 11 people out of 17 students is in the medium difficulty category, this means that most students have begun to understand the molecular structure in biochemistry. In the material terms in biochemistry as many as 14.71% of students experience difficulties, this means that more than 80% of students understand terms in biochemistry. Students have been able to classify the 4 main groups of carbohydrates and the source of each carbohydrate as many as 14 people are already in moderate difficulty, 2 students are at a fairly easy level. This shows that students already understand terms in biochemistry, only 1 student who is indeed the whole of each question item with a variety of different materials is in the range of very difficult and very difficult. In question 5 it also looks like this, 9 students are in the fairly easy range, 7 students are in the very easy range, and 1 student who is still in the very difficult range. Students already understand the concept of vitamins and minerals needed by the body, the classification of these vitamins and minerals and also from which food sources contain each vitamin and mineral.

Table 3. Results of Analysis of How to Learn Biochemical Materials

|  |  |  |
| --- | --- | --- |
| **No.** | **How to Study** | **Persentase (%)** |
| 1. | Discussion | 19,70 |
| 2. | Lecturer's Explanation | 21,21 |
| 3. | Learn about videos | 12,12 |
| 4. | Studying Images | 9,09 |
| 5. | Using the app/software | 4,55 |
| 6. | Practicum | 27,27 |
| 7. | Assignment | 6,06 |

Based on the results of the data above, it can be seen that students like lectures with practicum methods, this indicates that students prefer their direct learning, so it is expected that in learning the lecture material in the classroom, lecturers can use an application / software that students can use to better understand the lecture material, this is based on the results of interviews with students who are the subjects of this study.

Learning difficulties in students related to biochemical materials as shown in Table 2. is a phenomenon that occurs in various higher education institutions as revealed by Bukhari, Muhammad, & Nasruddin (2019); Munawaroh et al., (2019); Usman (2019), Wodyaningrum &; Wijayanti (2019); Halmo et al., (2018); Lismaya (2017); and Rahmatan (2016). The learning difficulties of students of the Biology Education Study Program at one of the universities in West Sumatra include molecular structure, metabolic pathways and terms in biochemistry. These three categories of material are generally because biochemistry has a wide scope of knowledge, but usually has a short time to study (Munawaroh et al., 2019).

The structure of the molecule is usually presented in the form of a diagram. Similarly, metabolic pathways are usually presented in the form of flow charts. This is as Lowe (1993) states that diagrams are usually used to illustrate complex and abstract material information. Difficulties related to this material are due to difficulties in reading and interpreting diagrams and molecular illustration schemes (Schönborn, Anderson, & Grayson, 2001). Diagrams are usually interpreted at the surface level only without further understanding the meaning of the diagrams presented in biochemistry learning resources. Skills in interpreting diagrams are skills acquired by students through a series of learning experiences and are closely related to student prior knowledge (Lowe, 1993). Furthermore, errors in reading and interpreting molecular structure diagrams that are the basis of biochemistry can lead to misconceptions in biochemical materials and unable to understand more complicated and complex biochemical materials, such as molecular group change reactions and metabolism.

Difficulty in understanding metabolic pathways, in addition to being less able to read diagrams also because the material is detailed material (Wood, 1990). The presentation of metabolic pathway material in learning resources is generally in the form of a flow chart accompanied by molecular structure, chemical formula, molecular name, arrows describing the direction of the reaction, accompanied by enzymes that catalyze each change. Detailed material on metabolic pathways raises problems, which must be understood or memorized each step. This makes the problem of student learning difficulties in understanding biochemical materials increasing.

In biochemical materials, there are many terms used. As the structure changes, so does the term used, as well as the notation. For example, the term that is often used is glucose. In its discussion in biochemistry learning glucose is not just sugar, but further glucose is a simple sugar that belongs to the monosaccharide group. Glucose has the chemical formula C6H12O6. Another difficulty in understanding terms in biochemical materials is that there are other terms that must be understood and known. For example, exemplified by Wood (1990) one term, namely galactosemia. In order to understand galactosemia, students must be able to know about sugars, glycoside bonds, amino acids, proteins, enzymes, the hierarchical structure of metabolic pathways that concern the term. Difficulties in recognizing and understanding terms can make it more difficult for students to study biochemical materials.

Based on the results of the analysis, lecturers' explanations and discussions with both lecturers and colleagues are still the main choices of students. This reflects that existing learning resources, both books, videos, images and other media are still not able to be utilized optimally by students in building knowledge.

The diagnosis of student learning difficulties has implications for efforts to minimize and overcome student learning difficulties in biochemistry learning. Future efforts that can be made based on the data in Table 3 are to carry out various developments related to learning media such as videos, learning impressions equipped with images and animations so as to make students more focused and directed in understanding the material, improve the learning process, can also develop teaching materials that are easy to understand the language and have a sequence of material that is tailored to the needs of students in learning the material biochemistry.

Furthermore, based on the results of the analysis carried out, it is also necessary to develop biochemistry teaching materials that are 1) the content is tailored to the needs of prospective teachers, namely containing material in accordance with the Core Competencies and Basic Competencies of Science in Junior High School and Biology in Senior High School; 2) the language is simple so that it is easily understood by learners in this case students; 3) The presentation is coherent, so that it can help students to organize their thinking flow in studying biochemistry. The teaching materials developed should also contain the relationship between biochemical materials and everyday life so that student knowledge can be directly related to reality. Thus, it is hoped that the teaching materials developed can encourage students to be able to learn meaningfully and be able to understand biochemical materials well for their own use when lectures can also be implemented when teaching later in school.

**Conclusion**

Based on the presentation of the results and discussion, it can be concluded that student learning difficulties are related to biochemical material, namely about molecular structure, metabolic pathways and terms in biochemistry, in general, the way to learn biochemistry that is liked by students is through lecturer explanations and discussion activities, learning resources used by students in studying biochemistry material in general are using data from the internet, Explanation of lecturers and biochemistry books.

Further research that can be done is to develop various teaching materials that can help students to learn which can be in the form of learning videos, easy-to-understand textbooks, modules, practicum instructions and interesting and easy-to-understand broadcast materials.

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