HIGH SCHOOL BIOLOGY TOPICS THAT PERCEIVED DIFFICULT BY UNDERGRADUATE STUDENTS

MATERI BIOLOGI SEKOLAH MENENGAH ATAS (SMA) YANG DIANGGAP SULIT OLEH MAHASISWA SARJANA STRATA I

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Abstract
Biology is a science subject which on the one hand becomes a favorite subject for many students, but on the other hand has many topics that are considered difficult by many students. The aims of this study was to map the difficult topics of biology in senior high school based on the opinion of undergraduate students. This present study used survey research design. The participant of this study was the undergraduate student of class of 2017 majoring in Biology in one of the state universities in Malang. The instrument used in this study was a questionnaire of difficulty topics on high school biology subject and descriptive analysis was used as data analysis techniques. The result of this study was Genetics, Metabolism, and Cell Division were the first, second, and third most difficult topics in XII grade. The Immune System, the Coordination System, and the Plant Tissue were the first, second, and third most difficult topic in XI grade. Protista, Monera, and Virus were the first, second, and third most difficult topics in X grade. Genetics, Immune System, and Metabolism also selected into three topics of all grades that were considered most difficult by undergraduate students majoring in Biology.

Keywords: biology subject, learning difficulty, senior high school

Introduction
In today's modern era, science has been positioned as the backbone of a country's progress in various life's aspects (Buah & Akuffo, 2017). In addition, the various concepts discussed in science have an important role in the daily life of human beings in the 21st century (Bennett & Hogarth, 2009). One of the benefits, people are able to identify the various components that are closely related to their healthy lifestyle (Buah & Akuffo, 2017). The benefits
will be apparent when a person is able to relate things in their daily life to the concepts of science, especially to the concepts studied in biology.

Biology is a branch of science that studies about life-related matters. Over the past two decades, biology has experienced exponential growth (Chu, 2008). Various knowledge learned from Biology is increasingly applied to solve various human problems, such as issues of health, agriculture, livestock, and other vital areas (Chu, 2008; Reece et al., 2011). Due to the various benefits provided, Biology becomes the most popular choice among other science disciplines by some students.

However, despite the popularity of Biology, based on various studies, it was revealed that many students often had low academic achievement in this subject (Hasibuan & Djulia, 2017; Kusumawati, 2016). The findings are in line with the fact that many students consider science as difficult subject to learn (Ogunkola & Samuel, 2011). The condition is not only found at the university level, but also at the secondary school level (Buah & Akuffo, 2017). This condition is inseparable from the nature of science where studying science can be complex because it emphasizes on integrating, organizing, synthesizing, as well as analyzing information or concepts (Ziegler & Montplaisir, 2014).

The study of biological learning difficulties has been studied by researchers from around the world (Buah & Akuffo, 2017; Çimer, 2012; Tekkaya, Ozkan, & Sungur, 2001; Topçu & Şahin-Pekmez, 2009). The study conducted by Çimer (2012) reported that there were five topics that has been perceived as most difficult to learn by XI grade students in the Rize district of Turkey in Biology subjects. Those topics were material cycles, endocrine systems, aerobic respiration, cell division, as well as genes and chromosomes. Another study in Turkey also reported that junior high school students in Izmir have difficulty in studying Genetics (Topçu & Şahin-Pekmez, 2009). The study conducted by Tekkaya et al. (2001) informed high school students in Turkey perceive hormonal, gene and chromosomal, mitosis and meiosis, nervous system, and Mendelian genetics as topics that are difficult to learn. On the other hand, students identify cell and organelle as well as ecology as an easy topic.

In addition, the respiratory system and circulatory system in humans are also reported as the topics that is considered the most difficult to learn by junior high school students in Techiman North District, Ghana (Buah & Akuffo, 2017). Etobro & Fabinu (2017) who did research on senior secondary students in Lagos States, Nigeria also reported that students often have difficulty studying five major topics in Biology subjects. Those topics are nutrient cycling in nature, ecological management, conservation of natural resources, pest and disease in plants agriculture, and reproductive systems in plants. In Indonesia, the study of Muspikeawijaya, Iswari, & Marianti (2017) also reported that high school students in Luwu Timur District had difficulties in understanding the concept of cell metabolism.

Various causes are reported to be the reason why many students have difficulty in learning Biology. Based on student responses and teacher interviews collected by Tekkaya et al. (2001), the source of biological learning difficulties was caused by terminology, textbook, teaching methods, curriculum, abstract, and interdisciplinary nature of concept. In other research reports, Etobro & Fabinu (2017) reported teaching strategies, student attitudes, lack of learning resources, along with student learning habits were the cause of difficulty students learn some topics in Biology. On the other hand, Çimer (2012) points out five main reasons why Biology was difficult to learn. Those reasons were the nature of the topic, teacher teaching styles, ways of learning and students habit, negative feelings and student attitudes on some biological topics, and lack of learning resources. Another report by Muspikeawijaya et al. (2017) also reported that students' learning difficulties in Biology subjects were caused by low learning intensity, teacher centered teaching strategies and facilities and less learning infrastructure supporting the learning process of Biology.

In Indonesia, studies of biological learning difficulties have also been made
several times. However, when analyzing research reports that have been published online, the trends and characteristics of research on student learning difficulties in Indonesia are different from those in other countries. Student learning difficulties research that attempts to map difficult concepts is hard to find. An example of research in Indonesia that attempts to map difficult concepts is Mardin’s (2017) research that examined learning difficulties in grade XII students in senior high school in Palopo City. Several other studies have only reported biological characteristics that made this subject become difficult to learn (Nafisah, 2011) and the common factors that caused students’ difficulties to study biology (Zikra, 2016). The rest, most of the research on students’ learning difficulties toward biology was more focused on the causes of students having difficulties in just one topic/concept (Alawiyah, Muldayanti, & Setiadi, 2016; Budiman, 2018; Marisa, Lestari, & Karno, 2016; Muspikawijaya et al., 2017; Ritonga, 2016; Sari, 2015).

Based on the information presented, it is necessary to conduct a research that trying to map the topic that is considered difficult by the students. By conducting the student perception survey of topics in high school, the purpose of this study is to map the existing materials at each grade level. Usually, research is only done on one grade level or only on one topic or concept. Third, this research asks respondents to determine which material they are positioning as the first, second, and third most difficult topics. In the previous study, respondents were only asked to determine which materials they considered difficult without ranking them into the three most difficult materials.

**Research Methods**

**Design of the Study**

This research used survey research design. A quantitative approach was used as a research method in determining which topics are considered the most difficult by undergraduate students. This research was conducted in Biology Department from one of the state universities located in Malang, East Java, Indonesia. This study was conducted from April to June 2018.

**Research Participant**

This research was conducted on the first level of undergraduate students majoring in Biology (student of class of 2017). The total participants involved in this study were 128 students. Participants consisted of 17 men and 111 women. The age range of participants is from 18 to 22 years. A total of 89 participants were undergraduate students of Biology Education Program, while 39 were undergraduate students of Biology Program.

**Instrument and Data Analysis**

The instrument used in this study was a questionnaire of difficulty topics on high school biology subject. At the beginning, the questionnaire asked for information about student identity. Then the questionnaire serves a selection of topics that directs students to choose which topic from each grade were deemed the most, second, and third difficult. After that, students were also asked to sort the three most difficult topics from all biology topics in senior high school.
(from XII to X grade). In addition, students were also asked to provide reasons for the choices they provide. Data analysis techniques used in this study was descriptive statistics using percentage presented in bar graph.

**Results and Discussion**

The findings obtained from this study were organized based on research questions: difficult topic distribution in XII grade, difficult topic distribution in XI grade, difficult topic distribution in X grade, and difficult topic distribution in all grade of high school.

**The Three Most Difficult Topics in XII Grade**

A total of 128 participants have identified three of the most difficult topics in XII grade. Five topics that were most often considered as the first, second, and third most difficult topics are presented in Figures 1, 2 and 3 respectively. Based on those figures, it was known that Genetics (73.4%) was considered the most selected as the most difficult topic in XII grade by students, while metabolism (42.2%) and cell division (35.9%) were the most selected as the second and third most difficult topics considered by undergraduate students majoring in Biology. Pekmez (2009) also conducted research on students' difficulties in studying the various concepts of Genetics and reported that most students can only memorize the concepts but have difficulty understanding the concepts.

Two other topics reported as the most difficult topics in this study were Metabolism and Cell Division topics. Similar to Genetics, some previous research reports also confirm metabolism (Muskikawijaya et al., 2017) and cell division as a topic often perceived as difficult by students (Çimer, 2012; Mardin, 2017; Tekkaya et al., 2001). Moreover, Mardin (2017) reported that metabolism was also the most difficult topic from the point of view of biology teachers.

**The Three Most Difficult Topics in XI Grade**

Five topics that were most often considered as the first, second, and third most difficult topics are presented in Figures 4, 5 and 6 respectively. The information obtained from the response of 128 participants in this study was the Immune
System (35.9%) was the topic in XI grade that was considered the most widely selected as the most difficult topic, while the coordination system (26.8%) was the most selected as the second difficult topic. Coordination system was also most selected as the third most difficult topic considered by undergraduate students majoring in Biology (17.5%). Beside these two topics, plant tissue (16.7%) also includes the topic that often chosen as the third most difficult topic by students.

Several reports also confirm that the immune system (Sitinjak, 2018; Suhartono, 2015), coordination system (Çimer, 2012; Mardin, 2017; Ceren Tekkaya et al., 2001), as well as plant tissue (Kusumawati, 2016) often considered as difficult topics by the students. In his report, Sitinjak (2018) informed that students' learning difficulties on the immune system topic at SMAN 9 Medan were included in the high category, while Suhartono (2015) recommends the use of interactive multimedia to help students in studying the immune system. Related to the Plant Tissue topic, because of the difficulty of this topic, students tend to obtain learning outcomes under minimal criteria, such as reports reported by Kusumawati (2016).

As a note, this study also revealed that beside the five topics presented in Figures 4, 5, and 6, there were other topics that some students considered to be difficult topics, i.e. Cell, Digestive System, Excretion System, Reproduction System, and Respiration System.

**Figure 4.** Five topics were most often chosen as the most difficult topics in XI grade

**Figure 5.** Five topics were most often chosen as the second most difficult topics in XI grade

**Figure 6.** Five topics were most often chosen as the third most difficult topics in XI grade

**The Three Most Difficult Topics in X Grade**

Five topics that were most often considered as the first, second, and third most difficult topics in X grade are presented in Figures 7, 8 and 9 respectively. Based on Figure 7, it can be seen that Protista (27.6%) was the most widely selected topic as the most difficult topic by students, while Monera (21.3 %) and Virus (18.1%) were topics considered the second and third most difficult topics by undergraduate students majoring in Biology.

Several previous reports also confirmed that Protista (Fitrahmawati, Sukiya, & Sudarsono, 2017), Monera (Sapuroh, 2010), as well as virus (Hasibuan & Djulia, 2017) were biological topics that are often considered difficult by students. In his report, Fitrahmawati et al. (2017) informed students' learning difficulties on the topic of Protista mainly occurred in the indicator: "understand the reproduction of..."
Protista”, Sapuroh (2010) that conducted the research in MAN Serpong Tangerang informed 100% of the students got the score under the minimum criteria after they answered the objective test questions on Protista topic. On the other hand, Hasibuan & Djulia (2017) report informed students' difficulties in studying Virus topics lies in some indicator, such as: "identifying virus characteristics", "explaining how virus replication", and "differentiating viral structure with other creatures".

Figure 7. Five topics were most often chosen as the most difficult topics in X grade

Figure 8. Five topics were most often chosen as the second most difficult topics in X grade

As a note, this study also revealed that beside the five topics presented in Figures 7, 8, and 9, there were other topics that some students considered to be difficult topics, i.e. Biodiversity, Ecosystem, Fungi, and The Nature of Biology.

The main factors causing some biological topics to be considered difficult by the students were also varied. From the diversity of factors, the causes of these difficulties can be grouped into five categories: abstract concepts, too many concepts, less understandable terms, difficulty understanding the content of the lesson, and “others” categories. Table 1 presents the percentage distribution of the causes of learning difficulties for each topic based on student responses. Based on Table 1, the most common factor causing Genetics difficult was because its concept is difficult to learn, while the most common cause for metabolism and cell division became difficult topics were too many concepts studied in metabolism and cell division contains many foreign terms. Moreover, too many concepts learned is also the most common factor causing the topic of Coordination Systems, Plant Tissue, and Protista into topics that were considered difficult by students. On the other hand, the existence of foreign terms becomes the most common factor causing the Immune System and Virus into topics that were considered difficult, while Monera was considered difficult because the concepts are difficult to understand by students.

Figure 9. Five topics were most often chosen as the third most difficult topics in X grade

The four main factors that shown in Table 1 were in line with Çimer’s (2012) reports which reported the nature of the topics (such as biology has too many concept, various biological events cannot be seen with the naked eye, some concepts are too abstract, and many foreign terms) were identified as main factors causing some topics in biology have perceived as difficult topic by students. Furthermore, some prerequisite concepts are required by students to understand certain concepts. If they do not master the prerequisite concepts, students will have difficulty understanding the concepts they are studying (Tekkaya et al., 2001). Moreover,
some prerequisite concepts are required by students to understand certain concepts. If they do not master the prerequisite concepts, students will have difficulty understanding the concepts they are studying.

Concerning the many concepts studied on several Biology topics, in studying Biology, students are continuously introduced with new information, theories, techniques, concepts, and new terminology (Almroth, 2015; Tekkaya et al., 2001). As a result, students are more likely to only remember concepts without understanding what they are learning (Çimer, 2012; Tekkaya et al., 2001). This condition is reflected in several topics, such as Metabolism, Coordination System, Plant Tissue, and several other topics. As the result, these topics were considered as difficult topics by the students.

Table 1. The Percentage Distribution of Factors Causing High School Biology Topics Perceived Difficult by Undergraduate Students Majoring in Biology (N= 128)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Topics</th>
<th>Abstract</th>
<th>Too Much</th>
<th>Foreign Term</th>
<th>Difficult to Understand</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>XII</td>
<td>Genetics</td>
<td>20.9</td>
<td>26.6</td>
<td>17.7</td>
<td>32.3</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>Metabolism</td>
<td>12.6</td>
<td>40.2</td>
<td>25.2</td>
<td>19.7</td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td>Cell Division</td>
<td>18.8</td>
<td>25.0</td>
<td>30.0</td>
<td>23.8</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>Evolution</td>
<td>33.9</td>
<td>37.3</td>
<td>10.2</td>
<td>16.9</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>Biotechnology</td>
<td>18.9</td>
<td>10.8</td>
<td>45.9</td>
<td>16.2</td>
<td>8.1</td>
</tr>
<tr>
<td>XI</td>
<td>Immune System</td>
<td>15.2</td>
<td>26.3</td>
<td>34.3</td>
<td>22.2</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>Reproduction System</td>
<td>4.8</td>
<td>61.9</td>
<td>23.8</td>
<td>9.5</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Coordination System</td>
<td>10.6</td>
<td>35.3</td>
<td>24.7</td>
<td>29.4</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Excretion System</td>
<td>6.7</td>
<td>53.3</td>
<td>13.3</td>
<td>26.7</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Respiration System</td>
<td>9.1</td>
<td>36.4</td>
<td>0.0</td>
<td>54.5</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Digestive System</td>
<td>0.0</td>
<td>60.0</td>
<td>20.0</td>
<td>20.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Circulation System</td>
<td>9.3</td>
<td>41.9</td>
<td>18.6</td>
<td>27.9</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>Musculoskeletal System</td>
<td>9.5</td>
<td>47.6</td>
<td>28.6</td>
<td>14.3</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Animal Tissue</td>
<td>10.0</td>
<td>46.0</td>
<td>24.0</td>
<td>18.0</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>Plant Tissue</td>
<td>5.3</td>
<td>43.9</td>
<td>28.1</td>
<td>22.8</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Cell</td>
<td>25.9</td>
<td>33.3</td>
<td>18.5</td>
<td>22.2</td>
<td>0.0</td>
</tr>
<tr>
<td>X</td>
<td>Ecosystem</td>
<td>8.3</td>
<td>25.0</td>
<td>25.0</td>
<td>33.3</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>Animalia</td>
<td>0.0</td>
<td>73.1</td>
<td>17.3</td>
<td>9.6</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Plantae</td>
<td>4.0</td>
<td>60.0</td>
<td>26.0</td>
<td>10.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Fungi</td>
<td>10.9</td>
<td>41.3</td>
<td>28.3</td>
<td>19.6</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Protista</td>
<td>13.7</td>
<td>40.0</td>
<td>32.6</td>
<td>12.6</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>Monera</td>
<td>21.1</td>
<td>23.7</td>
<td>25.0</td>
<td>28.9</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>Virus</td>
<td>31.3</td>
<td>14.1</td>
<td>35.9</td>
<td>18.8</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Biodiversity</td>
<td>0.0</td>
<td>84.0</td>
<td>4.0</td>
<td>12.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>The Nature of Biology</td>
<td>44.4</td>
<td>22.2</td>
<td>11.1</td>
<td>11.1</td>
<td>11.1</td>
</tr>
</tbody>
</table>

Another factor that causes the difficulty of the biological topic to be studied because the presence of foreign terms in large numbers. This condition is reflected in the topic of cell division that introduces students to various terms that they consider new and unfamiliar. This is one reason many of the students consider cell division a difficult topic. The existence of various foreign terms has also been reported as a source of learning difficulties of students in understanding Biology, for example in the Ceren Tekkaya et al. (2001) report.

The Three Most Difficult Topics from All Grades

After asking students to rank the three most difficult biological topics from each grade, students were also asked to rank the three most difficult biological topics from all
topics learned during high school (from all grades). Figure 10, 11, 12 present the research data that have been obtained in this study. According to those figures, Genetics (72.4%) was the most difficult biological topic of all subjects studied during high school, while the Immune System (29.9%) and metabolism (33.1%) were the second and third most difficult biological topics studied during high school.

Figure 10. Five topics were most often chosen as the most difficult topics in senior high school

Figure 11. Five topics were most often chosen as the second most difficult topics in senior high school

The results of this study that positioned Genetics as the most difficult topic in high school level. It is in line with the fact that Genetics is more often reported as a difficult topic from previous research results rather than other topics (Bahar, Johnstone, & Hansell, 1999; Chu, 2008; Çimer, 2012; Mardin, 2017; Tekkaya, 2002; Topçu & Şahin-Pekmez, 2009). Characteristics of the concepts that exist in Genetics, such as the existence of foreign terms, the many concepts that must be mastered and difficult to understand, and the abstract of these concepts make Genetics as difficult topic and disliked by students.

Conventional learning will exacerbate students' level of understanding of Genetic concepts. The condition will also reinforce the position of Genetics as a topic that is difficult to learn, not only at the middle school level, but also at the university level. In connection with these conditions, some research reports provide recommendations as a solution in the teaching of Genetics (Fauzi, 2017; Fauzi & Corebima, 2016a, 2016c, 2016b; Fauzi, Corebima, & Zubaidah, 2016; Fauzi & Ramadani, 2017). The solution, among others, using model organisms in studying some of the concepts of Genetics as well as conducting practical activities by conducting direct research on various phenomenon of Genetics being studied. On the other hand, in relation to the many concepts that must be studied on various biological topics and many problem appeared during learning process, various studies have been conducted by various researchers in Indonesia to overcome the various problems in biology learning (Fauzi & Pradipta, 2018). Some previous research reports have also reported and recommended the use of some appropriate learning models, such as cooperative script and reciprocal teaching (Buku, Mite, Fauzi, Widiansyah, & Anugerah, 2015; Fauzi, 2013; Fauzi & Ramadani, 2017; Ramadani, Fauzi, Sukmawati, & Corebima, 2015; Sukmawati, Ramadani, Fauzi, & Corebima, 2015) as well as the utilization of proper learning media (Emda, 2011; Mehdipour & Zerehkafi, 2013;
Conclusion

Mapping difficult topics from all levels of high school classes has been conducted in this study. The results of this study showed that certain Biological topics were more difficult than other topics. Genetics, metabolism, and cell division were the first, second, and third most difficult topics in XII grade. The immune system, the coordination system, and the plant tissue were the first, second, and third most difficult topic in XI grade. Furthermore, Protista, Monera, and Virus were the first, second, and third most difficult topics in X grade. When students were asked to determine the first, second, and third most difficult topics of all topics in high school (from all grades), Genetics, Immune System, and Metabolism selected into three topics that were considered most difficult by undergraduate students majoring in Biology.

Biology is a favorite subject for some students as well as subjects that have a variety of difficult topics. Information obtained in this study can be used to overcome the problems related to it. Through this report, high school teachers can find out which topics are often perceived as difficult by students, so that they can find a way out before teaching the topics. On the other hand, lecturers in the Department of Biology can also obtain information about students' assumptions on topics they have learned during high school. The information is expected to have implications on lectures in the Department of Biology, especially in lectures that discuss the topics.

One limitation of this study is its data collection technique just used questionnaires that ask students to rank the first, second, and third difficult topics along with their reasons for choosing those topics. Therefore, it is recommended in further studies, researchers using another questionnaire that has been developed by other researchers or other questionnaires that can gather more information.

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