HIGH SCHOOL BIOLOGY TOPICS THAT PERCEIVED DIFFICULT BY UNDERGRADUATE STUDENTS

MATERI BIOLOGI SEKOLAH MENENGAH ATAS (SMA) YANG DIANGGAP SULIT OLEH MAHASISWA SARJANA STRATA 1

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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

Abstrak

Biologi merupakan mata pelajaran sains yang di satu sisi menjadi mata pelajaran favorit bagi banyak siswa, namun di sisi lain memiliki banyak topik yang dianggap sulit oleh banyak siswa. Tujuan dari studi ini adalah untuk memetakan topik-topik biologi di Sekolah Menengah Atas (SMA) yang dianggap sulit berdasarkan pendapat mahasiswa-mahasiswa S1. Studi ini menggunakan desain penelitian survai. Partisipan pada studi ini adalah mahasiswa S1 angkatan 2017 Jurusan Biologi di salah satu universitas negeri di Malang. Instrumen yang digunakan pada studi ini adalah angket topik-topik sulit pada mata pelajaran Biologi SMA dan analisis deskriptif digunakan sebagai teknik analisis data. Hasil penelitian ini adalah Genetika, Metabolisme, dan Pembelahan Sel merupakan topik tersulit pertama, kedua, dan ketiga di kelas XII. Sistem Imun, Sistem Koordinasi, dan Jaringan Tumbuhan merupakan topik tersulit pertama, kedua dan ketiga dikelas XI. Protista, Monera, dan Virus merupakan topik tersulit pertama, kedua, dan ketiga di kelas X. Genetika, Sistem Imun, dan Metabolisme juga terpilih sebagai tiga topik dari seluruh kelas yang dianggap tersulit bagi mahasiswa Jurusan Biologi.

***Kata kunci**: mata pelajaran biologi, kesulitan belajar, sekolah menengah atas*

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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 Muspikawijaya, 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 Muspikawijaya 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 mapping the difficult concept 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 became 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 difficult topics that exist in high school biology subject based on information provided by undergraduate students majoring in biology. In more detail, this study is designed to answer the following questions.

1. Which high-school biology topic in XII grade that considered as the most difficult topic by undergraduate students?
2. Which high-school biology topic in XI grade that considered as the most difficult topic by undergraduate students?
3. Which high-school biology topic in X grade that considered as the most difficult topic by undergraduate students?
4. Which high-school biology topic (of all grades) that considered as the most difficult topic by undergraduate students?

This study has several aspects that distinguish it from previous studies. First, the participant of this research is the first level undergraduate students majoring in Biology. Usually, the research participant on the study that focus on the students' learning difficulty is high school students. Secondly, this study aims 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.

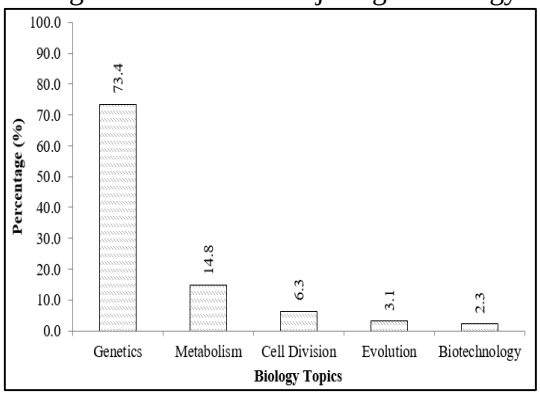

Figure 1. Five topics were most often chosen as the most difficult topics in XII grade

The findings that point to Genetics as the most difficult biological topic are in line with some previous research reports, as in the Mardin's (2017) report. The position of Genetic topics as one of the difficult topics in high school was also reported by studies from several other countries (Çimer, 2012; Tekkaya et al., 2001; Topçu & Şahin-Pekmez, 2009). Moreover, Topçu & Şahin-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 (Muspikawijaya 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.

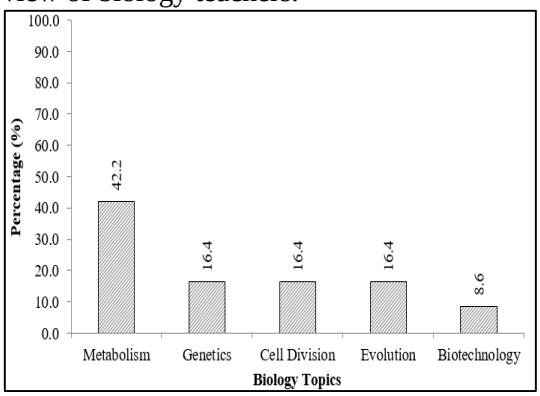

Figure 2. Five topics were most often chosen as the second most difficult topics in XII grade

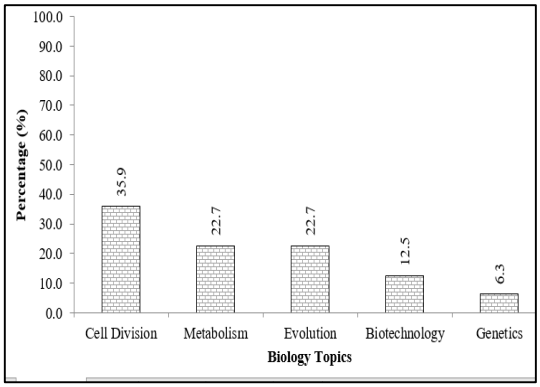

Figure 3. Five topics were most often chosen as the third most difficult topics in XII grade

The Three Most Difficult Topics in XI Grade

Five topics that were most often considered as the first, second, and third most difficult topics in XI grade 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.

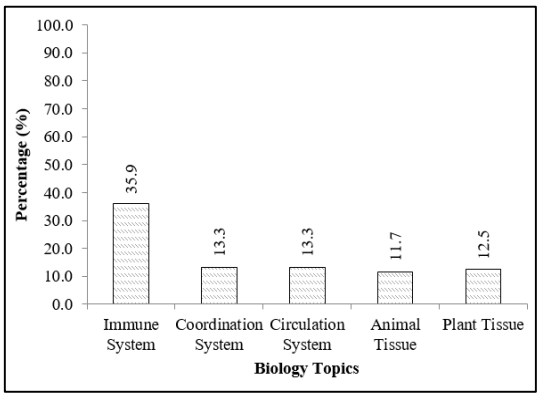

Figure 4. Five topics were most often chosen as the most difficult topics in XI grade

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.

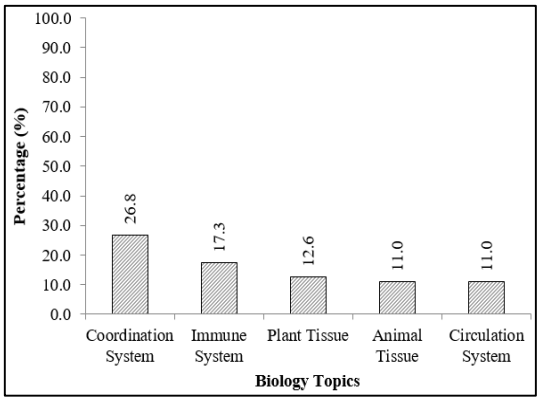

Figure 5. Five topics were most often chosen as the second most difficult topics in XI grade

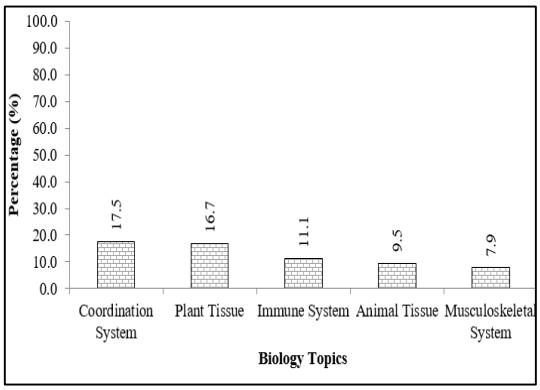

Figure 6. Five topics were most often chosen as the third most difficult topics in XI grade

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 (Fitarahmawati, 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, Fitarahmawati 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".

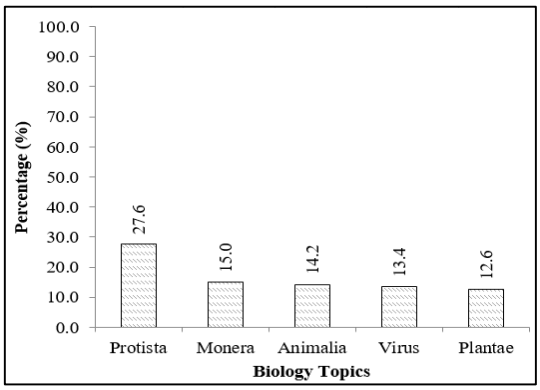

Figure 7. Five topics were most often chosen as the most difficult topics in X grade

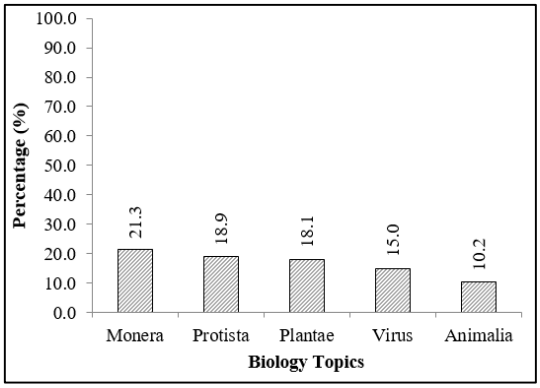

Figure 8. Five topics were most often chosen as the second most difficult topics in X grade

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.

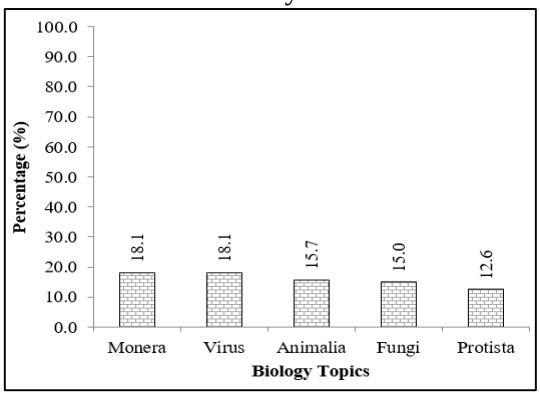

Figure 9. Five topics were most often chosen as the third most difficult topics in X grade

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)

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

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.

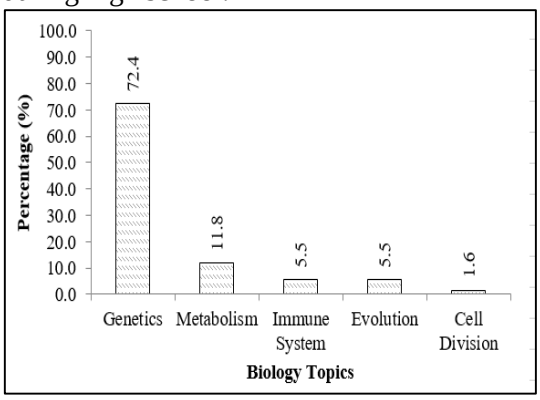

Figure 10. Five topics were most often chosen as the most difficult topics in senior high school

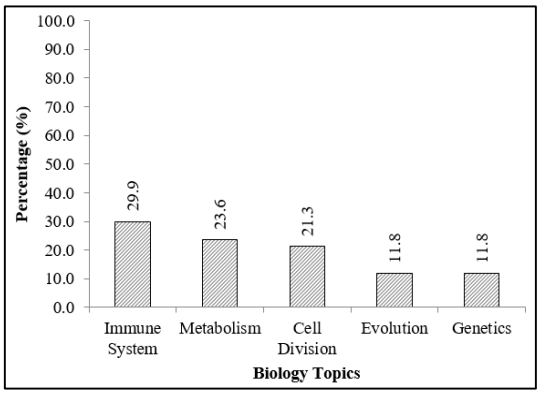

Figure 11. Five topics were most often chosen as the second most difficult topics in senior high school

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.

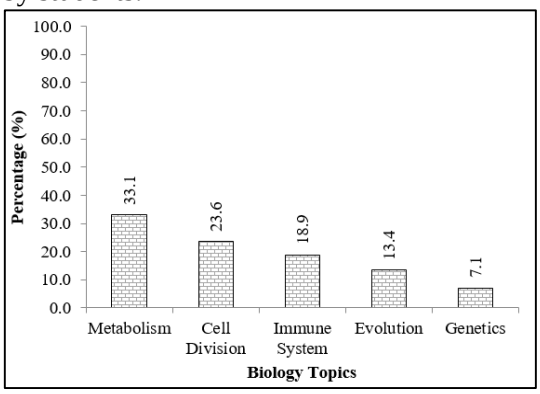

Figure 12. Five topics were most often chosen as the third most difficult topics in senior high school

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;

Mukti & Nurcahyo, 2017; Widiansyah, Indriwati, Munzil, & Fauzi, 2018).

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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References

Alawiyah, H., Muldayanti, N. D., & Setiadi, A. E. (2016). Analisis Kesulitan Belajar Siswa dalam Memahami Materi Invertebrata di Kelas X MAN 2 Pontianak. *Jurnal Biologi Education*, *3* (2), 9–20.

Almroth, B. C. (2015). The Importance of Laboratory Exercises In Biology Teaching; Case Study In An Ecotoxicology Course. *Pedagogical Development And Interactive Learning*, (september), 1–11.

Bahar, M., Johnstone, A. H., & Hansell, M. H. (1999). Revisiting Learning Difficulties In Biology. *Journal of Biological Education*, *33* (2), 84–86. https://doi.org/10.1080/00219266.1999.9655648

Bennett, J., & Hogarth, S. (2009). Would You Want To Talk To A Scientist at A Party? High School Students' Attitudes To School Science and to Science. *International Journal of Science Education*, *31* (14), 1975–1998. https://doi.org/10.1080/09500690802425581

Buah, E., & Akuffo, A. F. (2017). The Science Topics Perceived Difficult by Junior High School Students at Techiman North District : Effects On the Teaching and Learning of Science. *Imperial Journal of Interdisciplinary Research*, *3* (1), 503–509.

Budiman, M. S. (2018). *Analisis Kesulitan Belajar Siswa Kelas XII IPA SMA Negeri 3 Pontianak pada Materi Reproduksi Sel*. Universitas Tanjungpura Pontianak. Retrieved from http://jurnal.untan.ac.id/index.php/jpdpb/article/download/24276/75676575930

Buku, M. N. I., Mite, Y., Fauzi, A.,

Widiansyah, A. T., & Anugerah, D. Y. (2015). Penerapan Pembelajaran Cooperative Script Berbasis Lesson Study Sebagai Upaya Peningkatan Keaktifan Lisan dan Kecakapan Sosial Mahasiswa S1 Pendidikan Biologi Matakuliah Strategi Belajar Mengajar. In *Proceedings of the 2nd Seminar & Workshop Nasional Biologi, IPA, dan Pembelajarannya FMIPA UM* (pp. 603–606). Malang: Biologi FMIPA UM.

Chu, Y.-C. (2008). *Learning difficulties in genetics and the development of related attitudes in Taiwanese junior high schools*. University of Glasgow. Retrieved from http://theses.gla.ac.uk/168/

Çimer, A. (2012). What Makes Biology Learning Difficult and Effective: Students' views. *Educational Research and Reviews*, *7*(3), 61–71. https://doi.org/10.5897/ERR11.205

Emda, A. (2011). Pemanfaatan Media dalam Pembelajaran Biologi di Sekolah. *Jurnal Ilmiah Didaktika*, 12 (1), 149–162.

Etobro, A. B., & Fabinu, O. E. (2017). Students' Perceptions of Difficult Concepts In Biology In Senior Secondary Schools In Lagos State. *Global Journal of Educational Research*, *16*, 139–147.

Fauzi, A. (2013). *Pengaruh Kemampuan Akademik Terhadap Keterampilan Metakognitif, Hasil Belajar Biologi, dan Retensi Siswa SMA Kelas X dengan Penerapan Strategi Pembelajaran Cooperative Script di Malang*. Universitas Negeri Malang. https://doi.org/10.13140/RG.2.2.24659.99363

Fauzi, A. (2017). *Analisis Filogeni* Tarsius tarsier Form Buton *dengan Beberapa Spesies Tarsius dari Sulawesi Tengah, Sumatera-Kalimantan, dan Filipina Atas Dasar Gen MT-CO2 Sebagai Bahan Pengembangan Buku Panduan Penelitian Mata Kuliah Genetika II di Universitas Negeri Malang*. Universitas Negeri Malang. Retrieved from https://www.researchgate.net/publication/318563736_Analisis_Filogeni_Tarsius_tarsier_Form_Buton_dengan_Beberapa_Spesies_Tarsius_dari_Sulawesi_Tengah_Sumatera-Kalimantan_dan_Filipina_Atas_Dasar_Gen_MT-CO2_sebagai_Bahan_Pengembangan_Buku_Panduan_Penelit

Fauzi, A., & Corebima, A. D. (2016a). Fenomena Gagal Berpisah, Epistasis, dan Nisbah Kelamin pada *Drosophila melanogaster*. In *Seminar Nasional Biologi 2016* (pp. 283–288). Surabaya: Universitas Negeri Surabaya.

Fauzi, A., & Corebima, A. D. (2016b). Pemanfataan *Drosophila melanogaster* Sebagai Organisme Model dalam Mempelajari Hukum Pewarisan Mendel. In *Seminar Nasional Biologi 2016* (pp. 372–377). Surabaya: Universitas Negeri Surabaya.

Fauzi, A., & Corebima, A. D. (2016c). Pemanfataan *Drosophila melanogaster* Sebagai Organisme Model dalam Mengungkap Berbagai Fenomena Penyimpangan Rasio Mendel. In *Seminar Nasional Biologi 2016* (pp. 278–282). Surabaya: Universitas Negeri Surabaya.

Fauzi, A., Corebima, A. D., & Zubaidah, S. (2016). The Utilization Of Ferns As A Model Organism for studying Natural Polyploidization Concept In Genetics Course. In *International Conference on Education* (pp. 51–58). Malang: Universitas Negeri Malang. Retrieved from http://pasca.um.ac.id/conferences/index.php/ice/article/download/11/8

Fauzi, A., & Pradipta, I. W. (2018). Research Methods and Data Analysis Techniques In Education Articles Published By Indonesian Biology Educational Journals. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *4*(2), 123–134. https://doi.org/10.22219/jpbi.v4i2.5889

Fauzi, A., & Ramadani, S. D. (2017). Learning the Genetics Concepts Through Project Activities Using *Drosophila melanogaster*: a Qualitative Descriptive Study. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *3* (3), 238–247. https://doi.org/10.22219/jpbi.v3i3.4540

Fitarahmawati, Sukiya, & Sudarsono. (2017). Analisis Ragam Kesulitan Belajar Biologi Materi Protista MAN di Kabupaten Wonosobo Tahun Ajaran 2016/2017. *Jurnal Prodi Pendidikan Biologi*, *6* (7), 403–413.

Hasibuan, H., & Djulia, E. (2017). Analisis Kesulitan Belajar Siswa pada Materi Virus di Kelas X Aliyah Al-Fajri Tanjungbalai tahun pembelajaran 2016/2017. *Jurnal Pelita Pendidikan*, *4* (4), 16–24.

Kusumawati, M. U. (2016). Identifikasi Kesulitan Belajar Materi Struktur - Fungsi Jaringan Tumbuhan pada Siswa SMA Negeri 3 Klaten kelas XI Tahun Ajaran 2015/2016. *Jurnal Pendidikan Biologi*, *5* (7), 19–26.

Mardin, H. (2017). *Analisis Kesulitan Belajar Biologi Peserta Didik Kelas XII IPA SMA Negeri di Kota Palopo*. Universitas Negeri Makassar. Retrieved from http://eprints.unm.ac.id/5840/

Marisa, P., Lestari, R., & Karno, R. (2016). Analisis Kesulitan Belajar Siswa pada materi Tumbuhan kelas X di SMAN 1 Rambah Hilir Tahun Pembelajaran 2014/2015. *Jurnal Mahasiswa FKIP Prodi Pendidikan Biologi*, *2* (1). Retrieved from http://e-journal.upp.ac.id/index.php/fkipbiologi/article/download/613/530

Mehdipour, Y., & Zerehkafi, H. (2013). Mobile Learning for Education: Benefits and Challenges. *International Journal of Computational Engineering Research*, *3* (6), 93–101 (251–259). https://doi.org/10.1080/87567555.2011.604802

Mukti, I. N. C., & Nurcahyo, H. (2017). Pengembangan Media Pembelajaran Biologi Berbantuan Komputer untuk Meningkatkan Hasil Belajar Peserta Didik. *Jurnal Inovasi Pendidikan IPA*, *3* (2), 137–149.

Muspikawijaya, Iswari, R., & Marianti, A. (2017). Analisis Kesulitan Peserta Didik SMA/MA Kabupaten Luwu Timur dalam Memahami Konsep pada Materi Metabolisme Sel. *Journal of Innovative Science Education*, *7* (2), 252–263.

Nafisah, D. (2011). *Identifikasi Kesulitan Belajar IPA Biologi Siswa Kelas IX SMP Negeri 5 Ungaran*. Universitas Negeri Semarang. Retrieved from http://lib.unnes.ac.id/11193/1/10057.pdf

Ogunkola, B., & Samuel, D. (2011). Science Teachers' and Students' Perceived Difficult Topics in the Integrated Science Curriculum of Lower Secondary Schools in Barbados. *World Journal of Education*, *1* (2), 17–29. https://doi.org/10.5430/wje.v1n2p17

Ramadani, S. D., Fauzi, A., Sukmawati, I., & Corebima, A. D. (2015). Perbandingan Potensi Strategi Pembelajaran Cooperative Script dan Reciprocal Teaching dalam Memberdayakan Keterampilan Metakognitif, Hasil Belajar Biologi, dan Retensi Siswa SMA. In *Proceedings of the 2nd Seminar & Workshop Nasional Biologi, IPA, dan Pembelajarannya FMIPA UM* (pp. 655–661). Malang: Biologi FMIPA UM.

Reece, J. B., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Jackson, R. B. (2011). *Campbell Biology, Ninth Edition*. San Francisco: Pearson Benjamin Cummings.

Ritonga, N. (2016). Analisis kesulitan belajar pada materi pokok sistem pernapasan manusia di SMP Abdi Negara Asam Jawa. *Wahana Inovasi*, *5*(2), 410–415.

Sapuroh, S. (2010). *Analisis Kesulitan Belajar Siswa dalam Memahami Konsepn Biologi pada Konsep Monera (Studi Kasus di MAN Serpong Tangerang)*. Universitas Islam Negeri Syarif Hidayatullah. Retrieved from http://www.repository.uinjkt.ac.id/dspace/bitstream/123456789/3698/1/SITI%20SAPUROH-FITK.pdf

Sari, A. M. (2015). *Analisis Ragam Kesulitan Belajar Biologi pada Materi Animalia Kelas X Semester II SMA Negeri 1 Imogiri Tahun Ajaran 2014/2015*. Universitas Negeri Yogyakarta. Retrieved from http://eprints.uny.ac.id/28574/

Sitinjak, S. (2018). *Analisis Kesulitan Belajar Siswa pada Materi Pokok Sistem Pertahanan Tubuh Manusia di Kelas XI IPA SMA Negeri 9 Medan*

Tahun Pembelajaran 2016/2017. Universitas Negeri Medan. Retrieved from http://digilib.unimed.ac.id/28912/

Suhartono, B. P. (2015). *Pengembangan Multimedia Interaktif Berbasis Flash Untuk Meningkatkan Hasil Belajar Siswa pada Pembelajaran Sistem Imun Untuk Kelas XI SMA*. Universitas Negeri Malang. Retrieved from http://karya-ilmiah.um.ac.id/index.php/biologi/article/view/43084

Sukmawati, I., Ramadani, S. D., Fauzi, A., & Corebima, A. D. (2015). Perbedaan Pemberdayaan Retensi Antara Siswa SMA Akademik Rendah dan Tinggi Melalui Pembelajaran Cooperative Script dalam Pembelajaran Biologi. In *Proceedings of the 2nd Seminar & Workshop Nasional Biologi, IPA, dan Pembelajarannya FMIPA UM* (pp. 662–667). Malang: Biologi FMIPA UM.

Tekkaya, C. (2002). Misconceptions As Barrier to Understanding Biology. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *23*, 2590266.

Tekkaya, C., Ozkan, O., & Sungur, S. (2001). Biology Concepts Perceived As Difficult by Turkish High School Students. *Journal of Education 21*, *21*, 145–150. Retrieved from http://www.efdergi.hacettepe.edu.tr/200121CEREN TEKKAYA.pdf

Topçu, M. S., & Şahin-Pekmez, E. (2009). Turkish Middle School Students' Difficulties In Learning Genetics Concepts. *Journal of Turkish Science Education*, *6* (2), 55–62.

Widiansyah, A. T., Indriwati, S. E., Munzil, & Fauzi, A. (2018). I-invertebrata as an android-based learning media for molluscs, arthropods, and echinoderms identification and its influence on students' motivation. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *4*(1), 43–52. https://doi.org/10.22219/jpbi.v4i1.5476

Ziegler, B., & Montplaisir, L. (2014). Student Perceived and Determined Knowledge of Biology Concepts In An Upper-Level Biology Course. *CBE Life Sciences Education*, *13* (2), 322–330. https://doi.org/10.1187/cbe.13-09-0175

Zikra. (2016). Analysis of Factors Cause of Learning Difficulties of biology Class VII MTsS PGAI Padang. *BioCONCETTA*, *2* (2), 93–102.