EDUCATUM JSMT Vol. 8 No.1 (2021)
ISSN 2289-7070 / e-ISSN 2462-2451 (49-56)
https://ejournal.upsi.edu.my/index.php/EJSMT/index

Difficult Topics in Biology from the View Point of Students and Teachers based on KBSM Implementation

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Published: 23 April 2021

To cite this article (APA): Wan Mohamed Salleh, W. N., Che Ahmad, C. N., & Setyaningsih, E. (2021). Difficult topics in Biology from the view point of students and teachers based on KBSM implementation. *EDUCATUM Journal of Science, Mathematics and Technology, 8*(1), 49-56. https://doi.org/10.37134/ejsmt.vol8.1.6.2021

To link to this article: https://doi.org/10.37134/ejsmt.vol8.1.6.2021

Abstract

Biology subject is a part of the science curriculum ensuring that students can master in biology, aware of themselves and their environment, know the nature of science and biology as well as able to analyse the problems they encounter in daily life. Biology subject consists of many topics and concepts that must be comprehended by the students. However, there are several Biological topics that are considered difficult for many students. Thus, this study was carried out to identify the difficult topics in Form 4 biology from teachers' and students' perspectives. This study involved 352 students and 71 biology teachers from one of the districts in Selangor, Malaysia. The Biological Difficult Topics Questionnaire was used to assess the view on the difficulty of biology topics. Data from the questionnaire given were processed and analysed descriptively using the Statistical Package for the Social Sciences (SPSS) software. The results of this study revealed that the students have difficulty learning the topics of Nutrition, Cell Division and Chemical Composition in Cells. Meanwhile, the most three difficult topics identified by teachers were the Cell Division, Respiration and Nutrition. This shows that the Cell Division and Nutrition topics can be considered difficult by teachers and students. Based on the teachers' comments in the survey, it was found that the difficulties faced among students in learning the subject were due to the various terminologies and concepts that they could not understand. Findings provide valuable information that lead to a possible solution. The difficulties experienced by the students while learning Biology must be dealt seriously.

Keywords Biology subject, biology learning, learning difficulties, teaching difficulties, difficult Biology topic

INTRODUCTION

Biology is a branch in the field of science and technology that hugely contributes towards the development of society and progress of a country in various aspects of life. Biology does not only systematically study about living and non-living things, environment as well as interaction between life and environment [1], but the various knowledge learned from Biology are also increasingly applied to solve various human problems such as health and medical issues, food security, agriculture, livestock, industry, biological and environmental sciences, pollution control, sustainable utilisation of natural resources and other important areas [2]. All of this indicates that biology is one of the most important areas for better human life. Biology is the most common subject required for the admission into professional courses like medicine, pharmacy, nursing, agriculture, botany, zoology, microbiology, biotechnology, biochemistry, biophysics, anatomy, cell and molecular biology, computational biology, ecology, evolution, environmental biology, genetics, forensic biology, marine biology, neurobiology and physiology.

In Malaysia, Biology occupies a unique position in the curriculum of secondary school science education due to its importance as a science of life. Biology is specifically taught at the upper secondary level in the Malaysian education system for Form 4 and Form 5 students who took the science stream as elective subjects. The content of Biology subject is compiled not only to emphasise the understanding of biological knowledge, but also to apply it in daily life. Mastery in biology can be effective when one can relate things in his or her daily life to the concepts studied in biology [3]. In addition, understanding the concept of biology is very important as it acts as a basis for students to think further triggering the process of high-order thinking skills (HOTS) such as applying, analysing, evaluating, inventing, formulating principles and making generalisations [4]. The mastery of knowledge in biology can also generate numerous technological innovations and new discoveries in the field of science, technology and innovation that contribute to the community and national development [5].

The Biology curriculum syllabus drafted by the Malaysia Ministry of Education contain several topics that are loaded with various terms, terminology, processes and biological concepts that need to be understood and mastered by students. However, there are still students who do not master the field of biology. This is shown by the low achievement of students in Biology subject [6] and the achievement of students in Biology at excellent level, which are still unsatisfactory [7, 8]. The failure of students to apply biological concepts in solving problems of daily life affects the mastery of concepts, which in turn triggers learning difficulties in students [9]. Many students consider Biology as a difficult subject to learn [10, 11]. This problem, if not addressed from the beginning, will drag on to a higher level of education that in turn makes learning new information more difficult [12]. Experiencing difficulties in biological topics will also disrupt student learning, have a negative impact on student motivation and in turn prevent them from learning biology effectively.

Past studies around the world have discussed a lot about the difficulties faced by students in learning topics in biology. Many biology topics in the science curriculum have been perceived to be very difficult [13]. A study by Tekkaya, Özkan, and Sungur [14] found that Turkish students had difficulty studying the topics of hormones, genes and chromosomes, mitosis and meiosis, the nervous system and Mendel's Law. Meanwhile, a study conducted by Çimer [15] reported that there are five topics considered as the most difficult to learn by students in the subject of Biology namely the material cycle, endocrine system, aerobic respiration, cell and gene division as well as chromosomes. In Indonesia, the study of Fauzi and Mitalistiani [16] reported that the topics of Genetics, Cell Metabolism, and Cell Division were topics that were considered difficult by students. In addition, the classification of living organisms, mitosis and meiosis, material cycle, Mendel's Law, deoxyribonucleic acid (DNA) structure, and genetic code were among other difficult topics [12]. These studies clearly discussed more regarding students' views on the complexity of biological topics. Studies related to teachers' views were less conducted.

Therefore, it is important to conduct research mapping the difficult topics of Form 4 Biology syllabus in Integrated Secondary School Curriculum (*Kurikulum Bersepadu Sekolah Menengah, KBSM*) not only from the students' point of view, but also from the teachers. Hence, students' views were based on their experience of studying biology, which then gave an idea of what happened during their lesson. Meanwhile, the teachers' views were taken into account based on the experience of biology curriculum implementers and experience of teaching topics repeatedly depending on the number of years the teachers had been teaching. Although the Biology subject in secondary schools has begun to use the new syllabus starting from 2020, which is the Secondary School Standard Curriculum (*Kurikulum Standard Sekolah Menengah, KSSM*), researchers are still studying the KBSM Biology syllabus. This is because at the time this study started in 2019, the Biology subject is still using KBSM Biology syllabus. All the topics in the KBSM Biology syllabus are still retained in KSSM. However, KSSM was improved in terms of content and restructured the arrangement of Form 4 and Form 5 topics. There hardly any change in most of the content but more of the delivery approaches and updating the current biotechnology application.

The findings from this study are expected to provide information to teachers and researchers to investigate and identify topics that are considered difficult besides knowing the reasons why students perceive them as difficult. The findings will also stimulate researchers and curriculum development officials

to investigate why students experienced such difficulties and then find solutions to overcome these difficulties to further improve the quality of teaching and learning of biology.

The objective of the study

The objectives of the study were as follows:

1. Identify difficult topics in the Form 4 Biology Syllabus as perceived by students.
2. Identify difficult topics in the Form 4 Biology Syllabus as perceived by students from the teachers' point of view.
3. Identify the possible reasons that make these topics difficult from the teachers' point of view.

Research question

This study was conducted to answer the following research questions:

1. What topics in the Form 4 Biology Syllabus that are perceived as difficult for students to learn?
2. What topics in the Form 4 Biology Syllabus that are considered difficult for students to learn from the teachers' point of view?
3. What are the possible reasons that make these topics difficult from the teachers' point of view?

METHODOLOGY

This was a survey study that used descriptive quantitative data. The purpose of this study was to map the difficult topics found in secondary school biology subjects based on information provided by Biology teachers and students who take Biology as their elective subject. Biology Difficult Topics Questionnaire was used to obtain data on the level of difficulty topics in the Form 4 Biology Syllabus and then identify topics that are considered difficult from the point of view of teachers and students. Data were obtained in the form of a five-point Likert scale namely 1 (Very Difficult), 2 (Difficult), 3 (Moderate), 4 (Easy), and 5 (Very Easy). All topics were evaluated by secondary school students and secondary school Biology teachers according to the level of difficulty. In addition, teachers were also asked to give their opinion on why the selected topics are considered difficult. The data obtained were analysed by descriptive statistics using Statistical Packages for the Social Sciences (SPSS) software. Through descriptive statistics, a researcher can find out and describe the characteristics of a sample by looking at the percentage, frequency, mean score and standard deviation. The questionnaire was distributed to 352 Form 4 students who took Biology as an elective subject and 71 teachers who taught Biology, which were randomly selected from one of the districts in Selangor. Table 1 and table 2 shows the background of the study respondents involving a total of 352 Form 4 students who took Biology as elective subject and 71 teachers who teach Biology.

Table 1 Students' background

Achievements in Biology	Gender			Total
	Male	Female	Not specified	
A+	2	6		8 (2.3%)
A	15	21		36 (10.2%)
A-	15	45		60 (17.0%)
B+	16	25		41 (11.6%)
B	11	34		45 ((12.8%)
C+	17	45		62 (17.6%)
C	13	21		34 (9.7%)
D	19	14		33 (9.4%)
E	14	9		23 (6.5%)
G	8	2		10 (2.8%)
Not specified	0	0		0 (0.00%)
Total	130 (36.9%)	222 (63.1)		352 (100%)

Table 2 Teachers' background

Teaching experience (year)	Gender			Total
	Male	Female	Not specified	
1 to 5		6	1	7 (9.9%)
6 to 10	1	17		18 (25.4%)
11 to 15	1	17	2	20 (28.2%)
16 to 20		12		12 (16.9%)
More than 20	1	12		13 (18.3%)
Not specified		1		1 (1.4%)
Total	3 (4.2%)	65 (91.5%)	3 (4.2%)	71 (100%)

RESULTS AND DISCUSSION

All students and teachers involved in this study gave feedback on the difficulty of Biology topics through a given questionnaire. The topics studied in this study were Cell Structure and Organization (Topic 2), Movement of Substances Across the Plasma Membrane (Topic 3), Chemical Composition in Cells (Topic 4), Cell Division (Topic 5), Nutrition (Topic 6), Respiration (Topic 7), Dynamic Ecosystems (Topic 8) and Endangered Ecosystems (Topic 9). Descriptive statistics were used to determine frequencies and percentages of very difficult, difficult, moderate, easy and very easy biology topics as perceived by students and teachers. The difficulty level of the topic is shown in the frequency and percentage values as shown in Table 3.

Table 3 The frequency and percentage distribution of students and teachers' perspectives of difficult topics in the Form 4 Biology Syllabus

Topic	Difficulty level																			
	Very difficult (1)				Difficult (2)				Moderate (3)				Easy (4)				Very easy (5)			
	Frequency (f)		Percentage (%)		Frequency (f)		Percentage (%)		Frequency (f)		Percentage (%)		Frequency (f)		Percentage (%)		Frequency (f)		Percentage (%)	
	S	T	S	T	S	T	S	T	S	T	S	T	S	T	S	T	S	T	S	T
2	11	1	3.1	1.4	14	2	4.0	2.8	88	24	2.5	33.8	146	34	41.5	47.9	93	10	26.4	14.1
3	7	0	2.0	0.0	28	4	8.0	5.6	127	33	36.1	46.5	126	33	35.8	46.5	64	1	18.2	1.4
4	11	0	3.1	0.0	80	5	22.7	7.0	133	37	37.8	52.1	77	27	21.9	38.0	27	1	7.7	1.4
5	27	7	7.7	9.9	88	32	25.0	45.1	133	22	37.8	31.0	77	10	21.9	14.1	27	0	7.7	0.0
6	21	3	6.0	4.2	60	10	17.0	14.1	150	32	42.6	45.1	109	25	31.0	35.2	23	1	6.5	1.4
7	10	1	2.8	1.4	60	19	17.0	26.8	150	32	42.6	45.1	109	19	31.0	26.8	23	0	6.5	0.0
8	7	1	2.0	1.4	57	3	16.2	4.2	138	30	39.2	42.3	113	29	32.1	40.8	37	8	10.5	11.3
9	7	1	2.0	1.4	33	2	9.4	2.8	117	29	33.2	40.8	134	25	38.1	35.2	61	14	17.3	19.7

*S = Student, n = 325. *T = Teacher, n = 71. *2 = Cell Structure and Organization. *3 = Movement of Substances Across the Plasma Membrane. *4 = Chemical Composition in Cells. *5 = Cell Division. *6 = Nutrition. *7 = Respiration. *8 = Dynamic Ecosystem. *9 = Endangered Ecosystem.

Based on Table 3, the topic at the difficulty level of 'Very Difficult' with the highest frequency and percentage values was the topic of Cell Division by 27 students (7.7%) and 7 teachers (9.9%). The second highest topic was the topic of Nutrition, which was supported by 21 students (6.0%) and 3 teachers (4.2%). There were two topics at the difficulty level of 'Difficult' with the highest frequency and percentage values, which were the topics of Cell Division supported by 88 students (25.0%) and the topic of Chemical Composition in Cells, which was supported by 80 students (22.7%). Meanwhile, the topic of Cell Division was considered difficult by 32 teachers (45.1%), whereas the topic of Respiration was perceived as difficult by 19 teachers (26.8%). The two topics that were at the 'Easy' difficulty level with the highest frequency and percentage values were the topics of Cell Structure and Organisation represented by 146 students (41.5%) and the topic of Endangered Ecosystems by 134 students (38.1%). Meanwhile, the topic of Cell

Structure and Organisation was considered easy by 34 teachers (47.9%) along with the topic of Movement of Substances Across the Plasma Membrane by 33 teachers (46.5%). The two topics that were at the 'Very Easy' difficulty level with the highest frequency and percentage values were the topics of Cell Structure and Organisation by 93 students (26.4%) and the topic of Movement of Substances Across the Plasma Membrane by 64 students (18.2%). On the other hand, the topic of Endangered Ecosystems was considered easy by 14 teachers (19.7%) with the topic of Cell Structure and Organisation by 10 teachers (14.1%).

The difficulty level of the topics was then arranged according to the total mean score recorded by the analysed topic. The topics that obtain the lowest mean was considered as the most difficult. The results of the analysis are as shown in Table 4, which shows the sequence of topic difficulties in the Form 4 Biology syllabus according to the perceptions of students.

Table 4 The sequence of topic difficulties in Form 4 Biology Syllabus from the students' point of view

Topic	Mean score	Standard deviation	Sequence of Difficulty
Nutrition	2.95	.933	1
Cell division	2.97	1.041	2
Chemical composition in cells	3.00	.846	3
Respiration	3.21	.901	4
Dynamic ecosystem	3.33	.936	5
Endangered ecosystem	3.59	.947	6
Movement of substances across the plasma membrane	3.60	.940	7
Cell structure and organization	3.84	.965	8

Based on Table 4, the topic of Nutrition was identified as the most difficult for students because the mean score value was the lowest compared to other topics (M = 2.95, SD = .933). The second difficult topic was the topic of Cell Division (M = 2.97, SD = 1.041). The third difficult topic was the topic of Chemical Composition in Cells (M = 3.00, SD = .846). Meanwhile, Table 5 which shows the sequence of topic difficulties in the Form 4 Biology syllabus according to the perceptions of teachers.

Table 5 The sequence of topic difficulties in Form 4 Biology Syllabus from the teachers' point of view

Topic	Mean score	Standard deviation	Sequence of Difficulty
Cell division	2.49	.859	1
Respiration	2.97	.774	2
Nutrition	3.15	.839	3
Chemical composition in cells	3.34	.634	4
Movement of substances across the plasma membrane	3.44	.626	5
Dynamic ecosystem	3.56	.805	6
Endangered ecosystem	3.69	.871	7
Cell structure and organization	3.70	.799	8

Based on Table 5, the topic of Cell Division was the most difficult topic for teachers to teach compared to other topics found in the Form 4 Biology Syllabus (M = 2.49, SD = .859). The topic of Respiration (M = 2.97, SD = .774) and Nutrition (M = 3.15, SD = .839) was also considered difficult topic for them to teach. The views of students and teachers showed several similarities of opinion arguing that the topic of Cell Division and Nutrition is one of the difficult topics. Descriptive statistics using mean scores were presented in a bar graph to illustrate the mean scores of students and teachers as shown in Figure 1. Figure 1 illustrates the distribution of mean score for each topic in Biology subject, which was considered difficult from the point of view of students and teachers.

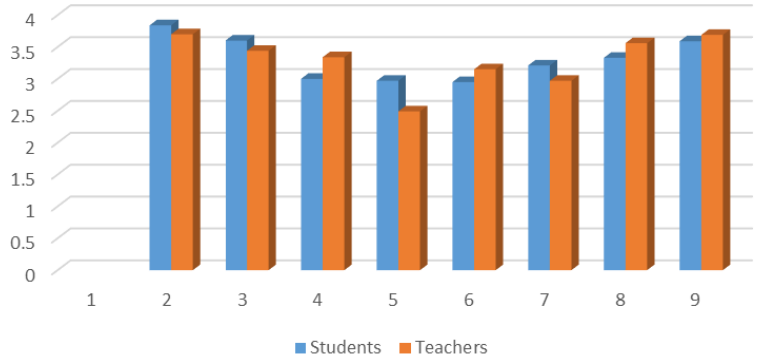

Figure 1 Mean score distribution for each Biology topic by students and teachers

Figure 1 shows that the topic with the lowest mean value was Cell Division with the mean score of M = 2.97 for students and M = 2.49 for teachers. This topic has been a difficult topic for students since a long time ago. In fact, students from various countries have been facing difficulties in learning this topic such as those from Indonesia [16], Turkey [14] and Malaysia [17]. Despite various efforts to address this issue, the topic of Cell Division remained difficult. Biology teachers also considered Cell Division as one of the most difficult subjects [18]. Mitosis has been one of the subtopics in the topic of cell division that is often considered difficult by students [9, 12, 19]. A study by Nordin & Kamar [17] showed that the number of students who were at an unsatisfactory level was higher than those who are at a good level in the topic of mitosis. There are still many students who experience confusion and do not understand the concept of mitosis [20]. In addition, meiosis has been also considered as a difficult subtopic to learn [9, 12, 19]. However, this topic needs to be mastered by students because the concepts of cell division, cell cycle, chromosome and homologous chromosomes are fundamental for further biology studies [21]. The topic of cell division involving mitosis and meiosis is an important basic concept for understanding the genetics and biology of molecules. Without understanding the basic concepts that are important in mitosis and meiosis, students will not be able to solve problems regarding genetic [14, 18, 22].

In addition, other difficult biological topics include nutrition [11, 13, 16], respiration [13, 15, 16], photosynthesis [12, 23], endocrine system and hormones [15, 23] and nervous system [23, 24]. This indicates that there are many difficult topics for students to master. Difficulties in learning these topics need to be overcome. Therefore, the causes that lead to the difficulty of these topics need to be studied.

Teachers' views on the causes that contribute to difficulties in biological topics were collected through open-ended questions. Teachers considered that the difficulty of the topics was due to several factors. Among them were concepts that are too abstract, concepts that are difficult to understand and various terms that are difficult to describe. The results of the analysis of the factors stated by the teachers in rationalising the categorisation of the most difficult topics in the subject of Biology are shown in Table 6.

Table 6 Factors of topic difficulty in perceptions of students and teachers

Factors	**Percentage of agreement (%)**
The concept is too abstract	15.2
The concept is difficult to understand	18.2
There are various terms that are difficult to describe	57.6
Others	9.1

From the analysis conducted, it was found that the main factor that influenced the teachers to categorise the level of difficulty of the topic was the various terms that are difficult to understand, which is 57.6%. This was followed by the factor of difficulty in understanding concepts by 18.2%, and concepts learned are too abstract by 15.2%. The many biological foreign and complex terms in the topic of Cell Division were considered as the main factors for the difficulty of this topic [13, 16]. The variety of terms that students need to learn is a major factor in the difficulty of this topic. This factor is supported by many

previous researchers. There are various terms that contribute to confusion and difficulty for students to understand cell division [9]. The processes involved in cell division are very complex and difficult to understand [18]. This situation causes students to learn by notes without understanding well, thus making learning becomes less effective and meaningful. Students regard knowledge as a set of facts that must be remembered and memorised [15, 25], which cause them to memorise materials or concepts without deep understanding. This situation causes the students to not master the concept well and leads to the problem of misconception in students [3, 9, 25].

In addition, biology contains abstract concepts that are indescribable and cannot be visualised. The abstract concepts are difficult for a teacher to provide effective learning experience to students [11]. This situation becomes a constraint for students to understand and master biology subject, which in turn triggers their negative perception towards biology. Abstract concepts in cell division include chromatin, chromatid, sister chromatids, centriole, centromere, chromosome, homologous chromosome, centrosome-centrioles, spindle fibres and other structures that change at each phase [19]. The Biology subject also contains a lot of information and concepts, which was one of the causes of this difficulty. Among the topics that contain many concepts is the topic of Nutrition. Due to that, the topic of Nutrition was also considered a difficult topic for students. In conclusion, the difficulty of this topic largely stemmed from the content of the biological subject itself. However, there are other factors that cause this difficulty such as problems arising from the teacher, problems arising from the student and problems arising from the other reasons such as learning aids that are not appropriately used [12].

CONCLUSION

In general, the results of this study indicated that certain topics are more difficult than others as perceived by students and teachers. The findings of this study have similarities between students' and teachers' views on the topic of Cell Division and Nutrition as difficult topics. The issues related to the teaching and learning of these topics may be a major contributor to the difficulties experienced by students in the learning of biology. Factors that contributed to difficulties in the view of teachers have been identified. The information obtained in this study can be used to overcome the difficulty of these topics and improve the effectiveness of students' biology learning. In addition, teachers would have the opportunity to plan and implement strategies, approaches and methods of teaching and learning biology that are appropriate for students before starting to teach these difficult topics. Diverse as well as interesting teaching and learning strategies, activities and methods are suitable for the needs of each topic. Innovative and creative student-centred teaching methods using appropriate teaching equipment and materials should be provided for effective and efficient classroom teaching-learning activity. This would allow the teaching and learning of biology to be interesting, fun besides able to make positive changes on student learning, increase the understanding of concepts and increase the motivation as well as encourage student engagement in learning biology.

ACKNOWLEDGMENT

The author would like to acknowledge the Scholarship and Financing Division, Ministry of Education Malaysia for the sponsorship of the "Hadiah Latihan Persekutuan" (HLP) that enabled this study to be implemented successfully. The author would also like to acknowledge the Department of Biology, Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris (UPSI) and those who extended their help in contributing to the completion of this manuscript.

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