

Research Article

Learning difficulties in comprehending virus and bacteria material for senior high schools

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ABSTRACT

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Previous research only focuses on the difficulties and factors causing learning difficulties without any solution. This study aimed to identify learning difficulties, factors, and alternative solutions overcoming the problems of learning difficulties about viruses and bacteria. Data collection was carried out through the provision of a concept mastery test involving 195 students (8 schools) and in-depth interviews conducted by involving 37 students (4 schools) who received the lowest test scores. Data analysis was performed using a percentage formula to determine the proportion of difficulties for each competency. The results showed that students had difficulty with the highest percentage of virus material, those were the competence of analyzing the role of viruses in life (85.64%) and virus replication process (83.21%). The competence in bacterial material which has the highest percentage of difficulty (77.26%) in identify bacterial classification. The factors causing students to have difficulty learning virus and bacteria consisted of the nature of the topic (77.03%), attitudes and learning habits (60.81%), teacher's teaching skills (37.84%), and school facilities (27.03%). Alternative solutions are: teachers reduce the content that is complex and detailed, carry out an interactive learning process (audiovisual/animation), providing more learning experiences through practical activities, and teaching through interesting ways.



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INTRODUCTION

Student's learning outcomes in the high school level for biology subjects in the Province of West Nusa Tenggara-Indonesia in 2016 were below the national average (Kintamani, 2016). There were three districts/cities with an average score above 61.00, namely Mataram City, Sumbawa Regency, and West Sumbawa Regency. There were two other districts/cities with an average score below 47.00, those were Bima City and Dompu District, also five districts with an average score below 41.00 namely, Bima City, North Lombok Regency, East Lombok Regency, West Lombok Regency, and Central Lombok Regency (Sudarwati,

2016). The results prove that students experience difficulties in the learning process, especially in biology subjects.

Students experienced difficulty learning different biology materials at each grade level. Grade X students had difficulty learning about viruses and bacterial material. This material as a whole was seen as the material with the highest percentage of difficulties compared to other materials at the level of State High Schools (SMA) on the island of Lombok, West Nusa Tenggara. Most of the students, which were 74.12% in grade X, had difficulty in studying and comprehending the viruses and bacteria. Grade XI students expressed challenges with the material of the hormonal system (21.35%). In contrast to grade X and class XI, biological material that was considered difficult by grade XII students was the material related to genetics and inheritance (33.57%) (Hadiprayitno, Muhlis, & Kusmiyati, 2019).

Concepts in virus and bacterial material that were considered difficult by students include understanding the characteristics of viruses, distinguishing the structure of the virus's body from other creatures, synthesizing how to replicate viruses, the role of viruses, and how to avoid themselves from the dangers of viruses such as influenza, AIDS, swine flu and others (Khan & Read, 2018; Oren, 2015; Redfern, Burdass, & Verran, 2015; Simon, Enzinger, & Fink, 2017). Furthermore, Simon et al (2017) state that students often assume viruses are bacteria and viruses are prokaryotic cells. This can occur because viruses and bacteria have similar body structures, as microorganisms. The concepts that are felt difficult by students on bacterial material according to Hidayatussaadah, Hidayati, and Umniyatie (2016) are displayed in the process of reproduction of Archaeobacteria and classification of Eubacteria based on cell wall characteristics.

Virus and bacteria material is the material that is often included in the competencies tested during national examinations in Indonesia (Setyaningrum, Ramli, & Rinanto, 2018). Viral and bacterial material is very often raised at the time of the exam, both for the test to determine the ability of students in grade X high school and in the biology Olympics (Cahyoratri, 2018; Sari, 2017). Most students cannot answer the question correctly. This is due to the lack of understanding of students on viral and bacterial material (Rusmalina & Putra, 2015; Setyaningrum et al., 2018). Learning difficulties will certainly affect the process and the results that will be obtained by students in learning. Cimer (2012) and Diki (2013) argue that students who have difficulty in learning biological concepts or materials will have an impact on their enthusiasm and the acquisition of their learning outcomes. According to Indriwati, Susilo, and Hermawan (2019), difficulty in understanding viral and bacterial material makes students less motivated to learn. The lower the learning motivation of students, the lower the quality of learning. As a result, Hasibuan and Djulia (2017) argued that it is difficult for students to obtain good results in learning so it is necessary to further analyze the difficulties experienced by students in understanding viral and bacterial material.

Identification of students' difficulties in studying viral and bacterial material has been done by several previous researchers (Cimer, 2012; Etobro & Fabinu, 2017; Mardin, 2017; Fauzi & Mitalistiani, 2018). The main reasons for students' difficulties in learning biology include: (1) the characteristics of learning topics, (2) undisciplined learning habits of students, (3) students' negative attitudes towards learning topics, (4) learning less supportive facilities, (5) physical, economic and psychological conditions of students who do not support the learning, (6) the teaching style of teachers that is less creative, and (7) the students' negative assessment of the teachers (Cimer, 2012; Mardin, 2017). Besides, learning difficulties are caused by students being unable to associate the topics studied with everyday life (Cimer, 2012). Etobro and Fabinu (2017) suggest the reasons for the difficulties of students in biology were mostly due to the teaching methods of teachers who were not following the material taught and the delivery of material that was not matched with practicum activities. According to Fauzi and Mitalistiani (2018), the use of terminology or Latin terms in the material is also one of the reasons why students fail to comprehend particular biology topics.

Based on these rationales, previous research as a whole only focuses on the difficulties and factors causing learning difficulties without any solution to overcome the learning difficulties experienced by students. This study aimed to identify learning difficulties experienced by students in understanding the concept of virus and bacteria, factors that cause difficulties, and alternative solutions overcoming the problems of learning difficulties of students about viruses and bacteria. The contribution of this study is the knowledge of learning difficulties and the disclosure of factors that cause students to have learning difficulties in studying viruses and bacterial substances. Based on this, various education practitioners can provide solutions to student learning difficulties, in addition to alternative solutions provided by researchers in this paper.

METHOD

Research type

This research was descriptive in the form of survey research. This study described the learning difficulties of students on the virus and bacterial material, the factors that cause students to experience difficulties, and alternative solutions in overcoming learners' learning difficulties in understanding Grade X's virus and bacterial material for state high schools in East Lombok Regency, West Nusa Tenggara Province-Indonesia.

Research time and place

This study was conducted on July and August 2019 in eight state high schools in the East Lombok Regency. The schools were SMAN 1 of Terara, SMAN 1 of Sikur, SMAN 1 of Masbagik, SMAN 2 of Masbagik, SMAN 1 of Sukamulia, SMAN 2 of Selong, SMAN 3 of Selong and SMAN 1 of Labuan Haji.

Research target/subject

The subjects in this study were the X graders of state high schools in East Lombok Regency. The determination of the sample was done by using a purposive sampling technique. This sampling technique was implemented to select schools to be surveyed randomly consisting of 30% of the total number of state high schools in East Lombok Regency. The class used as a sample in this study was class X Natural Sciences amounting to eight classes from eight different schools with a total number of 195 students.

Procedure

The procedure of this study began with the preparation of instruments for written tests on viral and bacterial material and in-depth interviews (guide). Next, students answered the questions in the instrument (test paper) to find out the learning difficulties. Then the interview process was carried out to identify the factors that caused the learning difficulties.

Data, instruments, and data collection technique

The data consisted of the percentage of scores obtained on each item and the percentage of factors causing learning difficulties. The instruments of this research were: 1) a written test of viral and bacterial material and 2) an in-depth interview guide.

The test questions included 30 multiple-choice items consisting of 15 items about viruses and 15 items about bacteria. The multiple-choice test questions were first tested to find out the validity and reliability. The validity and reliability scores of the questions used were 0.71 and 0.69, respectively. The range of competencies contained in the test questions included 40% of the C4 category questions and 60% categorized as C3 category, referring to the requirements that were available in the basic competency (or *Kompetensi Dasar/KD*) material. Test questions were arranged based on indicators of competency achievement (Grade Point Average/GPA) on virus and bacteria material to identify learners' difficulties including identifying the characteristics of viruses, distinguishing the structure of the virus body from other organisms, analyzing the process of viral replication, analyzing the role of viruses in life, and identifying the types of viruses. Whereas bacterial material consisted of identifying the characteristics, the body structure, the classification, the role of Archaeobacteria and Eubacteria in life and identifying ways of breeding bacteria.

The in-depth interview guide was utilized during the interview process and was carried out after getting the results of the test questions. The interview process was conducted for 37 students from 4 different schools. The four schools involved in the interview process were the schools with the lowest test scores among the 8 other schools. Students' responses during the interview process that had similarities were examined carefully and then grouped so that they formed categories. The students' responses during the interview process were identified according to the interview instrument indicators. Indicators used in the interview process included the nature of the material, the teaching style of the teacher in the classroom, students' attitudes towards the material, and students' learning habits in the learning process.

Data analysis technique

The data analysis technique employed descriptive statistics. The test results were used to find a picture of the proportion of students' difficulties and the factors causing learning difficulties. The results of the written test questions were analyzed by counting the number of correct and wrong answers from each question

representing the achievement indicators of competence and calculating each percentage of the answers. The percentage was calculated using Sugiyono's formula (2013), as in Formula 1:

$$P = F/N \times 100\% \quad (1)$$

where P: Percentage of the answers; F: The total number of each answer; and N: The maximum number of answers.

The percentage of correct answers was categorized into difficult or not difficult with the following intervals, 0% - 50% means "Difficult", 51% - 100% means "Not difficult" (Hidayatussaadah et al., 2016). Data from the in-depth interview process were analyzed by calculating the percentage of each category of answers. The percentage of each learning difficulty category proposed by students was calculated using Sugiyono's formula (2013) as well.

RESULTS AND DISCUSSION

The findings of this study were arranged based on the research objectives, including competencies that are difficult for students to learn on the virus and bacterial material, reasons for having difficulty learning these competencies, and teachers' views on strategies that make learning biology more effective in overcoming students' learning difficulties.

The three most difficult competencies for learners to learn about the virus and bacterial material

The data obtained from 195 participants were analyzed to show the proportion of learning difficulties experienced by students. The proportion of learning difficulties in virus and bacterial material based on test questions is presented in Table 1 and Table 2.

Table 1. Learning difficulties in virus material learning

No	Indicators of competency achievement	Wrong answer (%)	Correct answer (%)	Category
3.4.1	Identifying virus characteristics	65.81	34.19	difficult
3.4.2	Differentiating the structure of the virus body from other organisms	45.13	54.87	Not difficult
3.4.3	Analyzing the virus replication process	83.21	16.79	difficult
3.4.4	Analyzing the role of viruses in life	85.64	14.36	difficult
3.4.5	Identifying the types of viruses	64.96	35.04	difficult
Average percentage		69.15	31.05	difficult

Table 1 shows that in the virus material, students had difficulties in almost all competencies that existed in the competence, such as: identifying the characteristics of viruses, analyzing the process of virus replication, analyzing the role of viruses for life, and identifying the types of viruses. This is evidenced by the percentage of the number of incorrect answers (68.95%) which is higher than the percentage of the number of correct answers from students (31.05%). While in the competency to distinguish the structure of the virus body with other organisms, students have no difficulty, it can be seen from the number of correct answers of 54.87% compared to the percentage of the wrong answers which is lower at 45.13%. Competence with the highest level of difficulty in the virus material experienced by students is the competence in analyzing the virus replication process with the percentage of incorrect answers of 83.21% and analyzing the role of the virus for life that is 85.64%.

Table 2. Learning difficulties in bacteria material learning

No	Indicators of competency achievement	Wrong answer (%)	Correct answer (%)	Category
3.5.1	Identifying characteristics of bacteria	61.54	38.46	difficult
3.5.2	Distinguishing bacterial body structure	64.27	35.73	difficult
2.5.3	Identifying bacterial classification	77.26	22.74	difficult
3.5.4	Identifying the role of Archaeobacteria and Eubacteria in life	60.51	39.49	difficult
3.5.5	Identifying the method of bacteria breeding	69.23	30.77	difficult
Average percentage		66.56	33.44	difficult

As for the bacterial material, referring to Table 2 it can be seen that students had difficulties in all competencies that exist, including the act of identifying bacterial characteristics, differentiating bacterial body

structures, identifying bacterial classifications, identifying the role of Archaeobacteria and Eubacteria in life, and determining ways of bacterial breeding. The highest difficulty experienced by students in bacterial material was the competence in identifying the classification of bacteria with a percentage of incorrect answers as high as 77.26%. Based on the above review it can be concluded that there were three most difficult competencies for students in learning viral and bacterial material, namely analyzing the process of virus replication, analyzing the role of virus for life, and identifying bacterial classifications.

Several previous studies also revealed difficulties in the same topics among students (Harahap & Nasution, 2018; Hasibuan & Djulia, 2017; Hidayatussaadah et al., 2016). Harahap and Nasution (2018), for example, revealed that explaining how to replicate viruses and explaining the role of viruses in life are the most difficult competencies in virus material for students in high school level because most students consider these concepts as abstract and complex. Hidayatussaadah et al (2016) also reported that explaining the classification of Eubacteria based on cell wall characteristics being the most difficult competency for students.

Factors causing learning difficulties

The data on the factors causing learning difficulties in virus and bacterial material based on internal and external factors were obtained through the interview process. The type of interview used was in-depth interviews. The number of participants involved in the interview process was 37 participants. More details can be seen in Table 3.

Table 3. Factors that cause students learning difficulties in comprehending virus and bacteria material

Factor	Main category	Sub category	Examples of student's statements	N	%	\bar{x} (%)
External	Material characteristics	The topic depends on memorization	"... memorizing too much ..."	33	89.19	77.03
		The topic is abstract	"... few difficulties with pictures"	27	72.97	
		The use of foreign/Latin words	"... contains complicated and unfamiliar words .."	35	94.59	
		Topic Complexity	"The topic is too complicated to understand"	19	51.35	
	Teacher teaching skill	Not accompanied with enough practice	"In my opinion, students should do more observations in the learning process"	18	48.65	37.84
		Teacher skills when teaching	"Teacher's teaching style ..."	10	27.03	
	School facilities	Limited facilities and infrastructure	"We cannot conduct experiments because our school does not have the tools and test equipment."	10	27.03	27.03
Internal	Student's attitudes and study habits	Negative attitude towards the material	"... I'm not interested in the topic ..."	15	40.54	60.81
		Student's study habits	"Feeling bored while studying ..."	14	37.84	
		Student's study habits	"I don't repeat studying topics daily..."	16	43.24	

The data in Table 3 show students' responses regarding the reasons why they have difficulty in studying the virus and bacterial material. Five main reasons emerged, namely: the nature of the topic/material, teacher skills, school facilities, and student study habits. The nature of the material, teacher skills, and school facilities were included in external factors, while the attitudes and habits of students were included in internal factors that caused learning difficulties.

External factors were the most influential factors on learning difficulties experienced by students in studying virus and bacteria material. Characteristics/nature of the material was a factor causing the learning difficulties of students with the highest percentage of 77.03%, followed by factors of students' attitudes and habits with a percentage of 60.81%, then teacher skills, and school facilities with the percentages of 37.84% and 27.03 %. Students identified the nature of the topic/material as the main reason for their difficulties in learning viruses and bacteria. Based on Table 2 it can be seen that 77.03% of the participants disclosed that virus and bacteria material has learning objects that cannot be seen with the naked eye, have high material complexity, and there are many foreign/Latin words. Fauzi and Mitalistiani (2018) also report that the existence of various foreign/Latin terms with high frequency could be considered as a source of learning difficulties for students in understanding Biology material. Besides, students involved in this study revealed that a large number of foreign/Latin terms forced them to memorize the material when studying. Çimer (2012) stated that when learning activities in the classroom are not associated with students' daily lives and are not

matched by practical or experimental activities, it will certainly lead to the perception that viral and bacterial material is material that only requires memorization.

The next factor that resulted in students' difficulty in learning viral and bacterial material was the way of teaching. According to students, biology lessons were generally conducted through teacher lectures and delivered in teacher-centered style. Practical activities and student-centered activities were rarely used. The same thing was reported by Çimer (2012), Mardin, Nurhayati, and Ramlawati (2017), and Nofitasari and Sihombing (2017) which found out that the way of teaching which was not creative and monotonous caused students to not be motivated in classroom learning. Therefore, the competence and creativity of teachers were essential and needed to increase the enthusiasm and motivation of students to learn the material in Biology lessons. According to Çimer (2012), students tended to ignore the teacher's explanation and allowed the development of negative attitudes of other students if the teacher lacks mastery of the delivered materials.

The limited facilities at the school were also one of the reasons why students often have difficulty in learning, especially in studying viral and bacterial material. Some of the students reported that because their school did not have adequate biology laboratories or adequate teaching and learning materials, they did not practice the learning process as they had hoped (no-practicum). They stated that they could not conduct experiments or observations in the laboratory or on a student-centered learning style. This factor resulted in biology learning taught through teacher-centered activities. Etobro and Fabinu (2017), as well as Nofitasari and Sihombing (2017) also reported the same findings in their research on students in senior high schools, namely the unavailability of learning facilities made students experience difficulties in the learning process.

The final reason for students' difficulty in studying the selected material, according to them, was their daily study habits. As many as 60.81% of students stated that they did not study regularly, and did not repeat the material previously taught. In addition, some of them added that they were sometimes not interested/bored with what the teacher taught in class. As a result, students could not understand the material properly. In addition to determining factors that negatively affect student learning, understanding their opinions about something that makes learning more effective is very important, to improve the quality of teaching and learning in schools.

Suggested alternatives to overcome learning difficulties.

Below are the alternative problem solving to overcome the learning difficulties experienced by students on learning material for viruses and bacteria. The data obtained from the results of the Focus Group Discussion with East Lombok Regency biology subject teachers of 22 participants, were then analyzed entirely to find alternative solutions to problems regarding learning difficulties experienced by students to comprehend virus and bacteria material. The alternative solutions are presented in Table 4.

Table 4. Alternative solutions to overcome learning difficulties.

Main category	Sub category	Sample of teacher's statement
Reducing the content of the material	Reducing detailed knowledge	"... making a resume (summary) of the material ..."
Providing audiovisual learning media	Watching videos	"...having an interactive learning media in the form of animation that is audio-visual."
Conducting practicum	Doing experiments	"... providing more learning experiences to students through practical activities ..."
Designing interesting learning	Teaching the topics in a more interesting and fun way	"...making learning outcomes in the form of competed products to be rewarded..." "...using flashcard media..."

Alternative problem solving related to learning difficulties of students delivered by biology subject teachers in the FGD forum based on Table 4 consisted of four main categories namely reducing material content, adding audiovisual learning media, doing practical learning, and making learning more interesting and enjoyable for learners. Some of the suggestions given were related to the teacher, some others were related to the students themselves, such as increasing the discipline of students in the learning process, and some habits related to biology topic/material. One teacher commented that reducing material content or making a summary of the material that is complex and broad can improve the quality of learning in the classroom. The same assertion is expressed by Çimer (2012) and Mardin et al (2017) about material that is too much and dense, so it is necessary to reduce the content of the material to improve the quality of learning.

The next alternative problem solving recommended was that the teachers have to utilize the learning with audiovisual media in the form of animation. This is based on the characteristics of the material which includes

many abstract concepts and phenomena so that the right media is needed for better learning. Therefore, if the teacher uses a variety of visual learning materials and media, such as pictures, models, videos, and 3-D material in learning, it will certainly make learning more effective. The use of learning media is enough to help students understand the material because with media students can see what is learned and explained by the teacher (Nofitasari & Sihombing, 2017). Furthermore, the use of instructional media through materials and visual tools can help maintain knowledge for a long time and help remember information (Çimer, 2012).

Some other teachers provided alternative solutions to the problems by adding practical activities that have to be done regularly. This revealed that current biology learning included a few practice sessions. Practical activities can help students to be able to build and understand knowledge deeper. Diki (2013) assumes that learning activities must include investigative activities, to enable students to conduct investigations while studying Biology. This will foster students' creativity. When students are involved in learning and conducting experiments or observations, they can understand the topic and remember it easily because practical activities allow them to learn the topic through various cognitive activities, for example by doing, observing, communicating, thinking, and discussing (Almroth, 2015; Çimer, 2012).

The final suggested alternative solution was to make the learning process more interesting and enjoyable through flashcard media. Flashcard media is believed to be able to help students in overcoming learning difficulties related to the use of foreign/Latin terms and material that requires a lot of memorization. Several previous researchers (Grillo, 2011; Reeser & Moon, 2018) also reported similar findings, that the use of flashcards is proven to be effective in increasing students' knowledge related to new terms or vocabulary in learning. Grillo (2011), in his research, for example, claims that students find the flashcard helpful in learning biology related to foreign/Latin terminology. Moreover, Golding, Wasarhaley, and Fletcher (2012) mention, the use of flashcard media in the learning process is proven to improve student's learning outcomes.

CONCLUSION

The three most difficult competencies for students in learning virus and bacteria material were analyzing the process of virus replication, analyzing the role of viruses for life, and identifying bacterial classifications. Students revealed the factors that have caused them to experience difficulties in learning the material including the nature/characteristics of the material, the teacher's skills in teaching, the availability of school facilities, and the attitudes and learning habits of students. Alternatives to overcome the problem of learning difficulties experienced by students were; it is recommended that teachers reduce material content that is complex and detailed. The next alternative is to do an interactive learning process in the form of audiovisual animation so that students get an overview related to the materials to be studied. The last suggested alternative is to provide more learning experience to students through practical activities, in addition to delivering the learning material in a more interesting and fun way.

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