Biosfer: Jurnal Pendidikan Biologi

Virus-bacteria diagnostic test (vbd-test) in identifying biology teacher's misconception

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ARTICLE INFO	ABSTRACT
	Virus-Bacteria Diagnostic Test (VBD-Test) is three-tier diagnostic instrument for identification virus and bacteria topics. The purpose of this study was to determine the empirical validity of the VBD-Test and identify misconceptions of virus and bacteria topics in biology teachers in Malang using VBD-Test. The development research model used was the Treagust development model, namely (1) Defining content, (2) Obtaining information, and (3) Developing a diagnostic test. The empirical validity on the VBD-Test was carried out with the Pearson correlation test using Excel, while the reliability on the VBD-Test was carried out with a spearman brown split-half method using Anatest 4.0.2. There were six valid questions and eight invalid questions on the virus topic, while in bacteria topic, there were nine valid questions and six invalid questions. The identification results on teacher's concept of the virus topic were 33.33% understood the idea, 13.66% false positive, 35.53% false negative, 17.01% did not understand the concept, and 4.39% guessed. While the results of the identification of the teacher's concept of bacteria topic were 30.13% understood the concept, 9.07% false positive, 227.63% false negative, 23.05% did not understand the concept, and 10.09% guessed. Based on these results, if identification misconception is not made to the teacher, then the misconception will not be known by the teacher on any material, and the learning material submitted by the teacher will remain a misconception so that students will also suffer the same.

Suggested Citation

INTRODUCTION

Teachers who understand the topics will make students improve their misconceptions (Nurulwati, Veloo & Ali, 2014). If the teacher answers incorrectly and gives an explanation of the topics, then the student will also accept the wrong concept (Chaniarosi, 2014). Misconceptions on students can occur if the process of assimilating concepts before learning is obtained with the concepts obtained in class are not interrelated (Bayuni, Sopandi & Sujana, 2018). Misconceptions on teachers might occur due to low comprehension of subject matter in the field of biological sciences. While many concepts in biology are interrelated, and one concept understanding is the key to acknowledge others (Suparno, 2013; Bayuni et al., 2018).

The identification of teacher misconceptions is an essential first step towards better science learning (Yip, 1998). Many different measurement tools for misconceptions identification, like an interview, map concepts, open-ended multiple-choice questions, multiple-choice questions, and multilevel multiple-choice questions (Tsai & Chou, 2002; Treagust & Chui, 2011; Gurel, Eryilmaz & McDermott, 2015; Oberoi, 2017). Each measuring instrument has advantages and disadvantages (Kanli, 2014; Kirbulut & Geban, 2014). The advantages of multilevel multiple choice questions in the comparison of misconceptions are that they can measure a person's concept, can be used for a large number of samples, and are useful as a learning feedback process (Tan & Treagust, 1999; Kanli, 2014).

Using a three-tier diagnostic instrument for identification misconceptions can estimate misconceptions scores more accurately than one tier and two-tier tests because three-tier diagnostic instrument can compare misconceptions and new benefits (Kirbulut & Geban, 2014). Three-tier diagnostic instrument is more effective in assessment rather than conventional multiple-choice tests. It is more accurate in eliciting people's misconceptions because they can support some knowledge by using trust ratings (Dindar & Geban, 2011; Saat, Fadzil, Aziz, Haron, Rashid & Shamsuar, 2016).

Three-tier diagnostic instrument is one of the diagnostic tests that can be used to identify biology topics considered to be difficult by students. The topic of viruses and bacteria are the topics of learning biology in class X, which are considered difficult by undergraduate students (Fauzi & Mitalistiani, 2018). The results of questionnaire analysis using the Guttman scale on students in the Lamongan Regency and Malang City showed that students do not understand the concept of virus and bacteria by 45.16% and 56.33% (Zulfia, Susilo & Listyorini, 2019).

The low level of concepts mastery can cause misconceptions as well as many causes of misconceptions in students in the form of textbooks that are read by students, student understanding brought before starting learning, student translation of a phenomenon, and teacher explanations discussed (Oberoi, 2017). The teacher is one of the factors that can cause misconceptions in students (Wahidah, Saptono & Wiyanto, 2019). So that research is needed regarding the identification of teacher misconceptions using VBD-Test on virus and bacteria topics. VBD-Test is three-tier diagnostic instrument for identification virus and bacteria topics.

Three-tier diagnostic instrument have three levels of questions including the first as conventional multiple-choice step, the second as possible reason for the answers given question for the first tier, and the third being the level of confidence for the two tiers mentioned (Dindar & Geban, 2011). Some researches that has been done use of Cell Biology Diagnostic Test (CBD-Test) to determine students' misconceptions on cell biology material. CBD-Test also uses a three-tier diagnostic with a certainty response index for each item (Suwono, Prasetyo, Lestari, Lukiati, Fachrunnisa, Kusairi, Saefi, Fauzi & Atho'Illah, 2019). Misconception also occur in the concept of photosynthesis and respiration which involved 58 students from Biology Education of Sriwijaya University used ten questions of multiple choices and 6 of the choice with reasons (Susanti, 2018).

Biological topics that have also been identified to have misconception are endocrine systems, circulatory systems, digestive systems, respiratory systems, genetics, evolution, ecology, classification, energy, execration systems, inheritance (human inherited diseases and inheritance and environment), plants (parts, growth, photosynthesis , respiration and nutrition), and hearing

mechanism (Tekkaya, 2002; Hola, 2004; Yates & Marek, 2014). Other topics which level of misconception needed to be measured are the topics of bacteria and virus. This study aims to analyse the empirical validity, reliability, and the level of the difficulty of the VBD-Test and study the percentage of teachers' misconceptions using VBD-Test.

METHODS
Research Design
The development research model used was the Treagust development contain of (1) Defining content, (2) Obtaining information, and (3) Developing a diagnostic test (Treagust, 1988).

Population and Sample
The population in this study was the high school biology teachers in Malang, while the sample used was 18 biology teachers in Malang.
Instrument
VBD-Test has been validated by material experts and assessment experts and has been deemed suitable to be used in the identification of teacher misconceptions of virus and bacteria topics. VBD-Test compiled as many as 14 questions on virus topic and 15 questions on bacteria topic. Each VBD-Test item consists of three levels of questions. The first level was a question with five answer choices. The second level was the choice of reasons as many as five choices of answers, and the third level was the choice of beliefs as much as two, namely sure and unsure.

Research Procedure
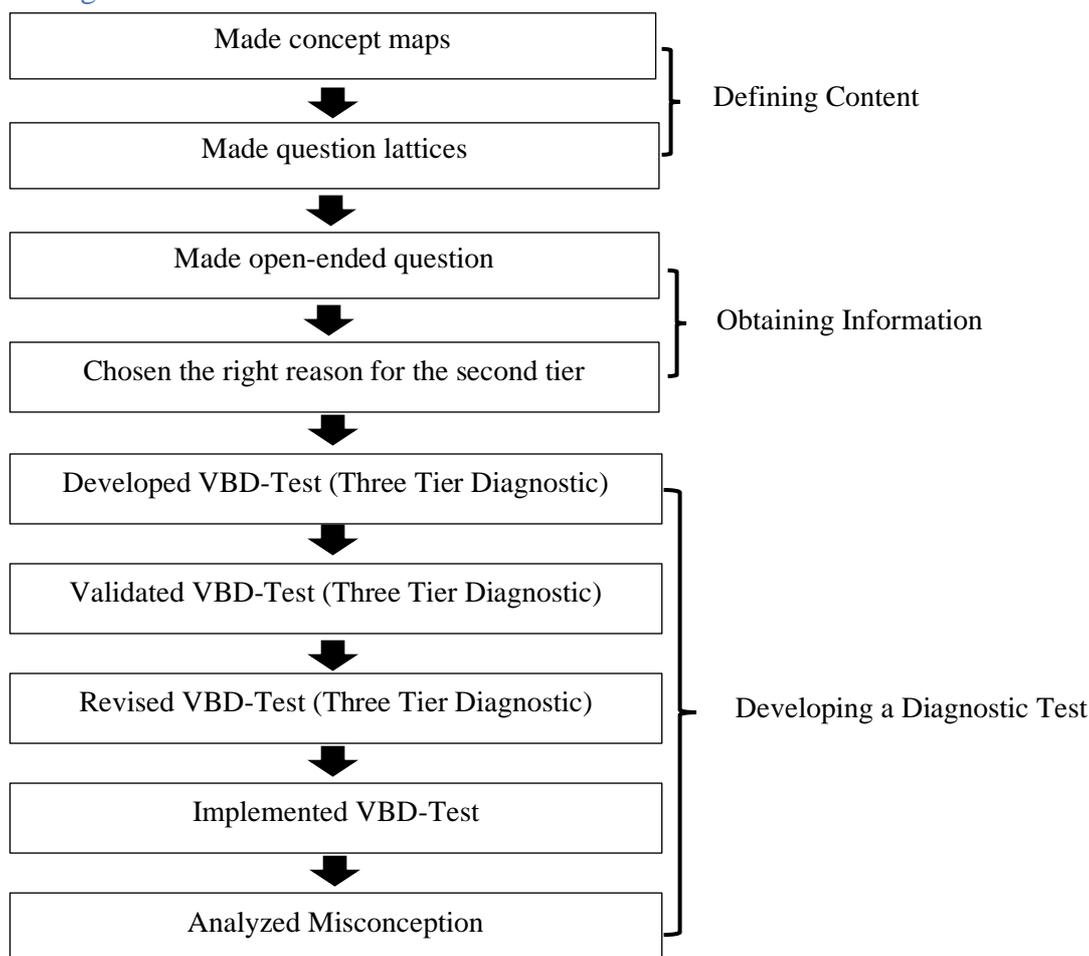The research procedure based on the Treagust development model was divided into three steps, as shown in Figure 1.

Figure 1. Research Procedure Diagram

1. Defining content

The stage of defining content was carried out by making concept maps of virus and bacteria topics to find out the essential submissions chosen in making VBD-Test. Question lattices was then design based on Minister of Education and Culture Regulation No. 37 of 2018 in essential competencies 3.4 Analyzing the structure, replication, and role of virus in life and 3.5 Identifying the structure, way of life, reproduction, and the role of bacteria in life.
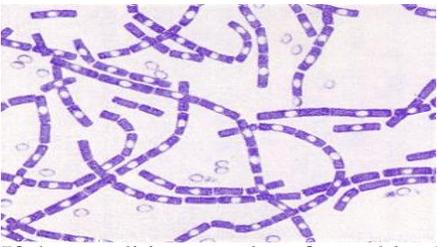
2. Obtaining information

The stage of obtaining the information in question was to develop an open-ended question, as shown in Table 1, and conduct trials to capture the reasons used in the second tier of the VBD-Test.

3. Developing a diagnostic test

The stage of developing a VBD-Test as shown in Table 2 began with compiling VBD-Test, validated the VBD-Test to the material expert and assessment expert, revised the VBD-Test in accordance with the suggestions from the validator, tested the VBD-Test to the biology teachers in Malang, and analyzed the misconception of the biology teachers in Malang.

Table 1

Example of Open-Ended Question for virus and bacteria topics

Concept	Open-Ended Question	Cognitive Level	Answer Key
Virus structure	Grade X students are having discussions in class, and five students have different opinions: 1. Siska: virus is a creature that contains parasites and has cell organelles 2. Toni: virus that can be seen microscopically and can be accessed by a binocular microscope 3. Nia: virus can be reproduced without being developed with other individuals 4. Ria: virus cannot be categorized as a living thing because it can be crystallized 5. Desi: all types of virus have a body structure consisting of capsid, DNA, and tail sheath Analyze students' opinions that are most correct regarding the structure of the virus ... a. Nia b. Ria c. Toni d. Desi e. Siska What is the reason of your choice above?	C4	B
Bacteria structure	 If the conditions are less favorable, Gram-positive bacteria as illustrated in the picture above can form endospores if the conditions are less favorable for the bacteria. The following are appropriate characteristics to state the characteristics of bacteria endospores are... a. has a size, shape, and position in stem cells that are not fixed b. formed from bacteria generative cells due to lack of nutrients	C3	C

    c. spore structure that is very resistant because it has a coat or coat

    d. live in environmental conditions that are not too dry, hot, and cold

    e. dynamic spores because they form depending on environmental conditions
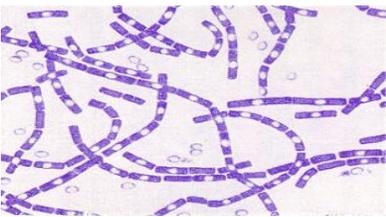
What is the reason you chose the answer above?

Data Analysis

Data analysis technique was carried out by analyzing the empirical validity on the VBD-Test with the Pearson correlation test using Excel while the reliability was carried out with spearman brown split-half method. The reliability and level of difficulty on the VBD-Test Analyzed by Anatest 4.0.2. Analyzing the results of the identification misconception of biology teachers in Malang using VBD-Test based on the concept determination category in Table 3.

Table 2

Example of VBD-Test

Concept	Open-Ended Question	Cognitive Level	Answer Key
Virus structure	Grade X students are having discussions in class, and five students have different opinions: 1. Siska: virus is a creature that contains parasites and has cell organelles 2. Toni: virus that can be seen microscopically and can be accessed by a binocular microscope 3. Nia: virus can be reproduced without being developed with other individuals 4. Ria: virus cannot be given as a living thing because it can be crystallized 5. Desi: all types of virus have a body structure consisting of capsid, DNA, and tail sheath Analyze students' opinions that are most correct regarding the structure of the virus ... a. Nia b. Ria c. Toni d. Desi e. Siska	C4	Tier 1: B
	The reason you chose the answer above is... a. Virus have cell organelles such as those of bacteria in the form of mesosomes, plasma membranes, cell walls, flagella, pili, cytoplasm, and plasmids b. Virus can multiply themselves using cell organelles they have, but virus can only replicate if they infect a host c. The size of a microscopic virus (smaller than a bacterium) cannot be observed with a light microscope but can be observed with a binocular microscope d. Virus are not living things because they can only live if they infect a host (very dependent on the host) and can be crystallized if they are not in the body of the host e. The virus has the same body structure, namely capsid to protect the inside of the virus body, DNA as genetic material, and the tail cover to protect the tail of the virus in injecting the host Are you sure about your answer? a. Sure b. Not sure	C2	Tier 2: D

Concept	Open-Ended Question	Cognitive Level	Answer Key
Bacteria structure	If the conditions are less favorable, Gram-positive bacteria like the picture above can form endospores if the conditions are less favorable for the bacteria. The following are appropriate characteristics to state the characteristics of bacteria endospores are... a. has a size, shape, and position in stem cells that are not fixed b. formed from bacteria generative cells due to lack of nutrients c. spore structure that is very resistant because it has a coat or coat d. live in environmental conditions that are not too dry, hot, and cold e. dynamic spores because they form depending on environmental conditions	C3	Tier 1: C
	What is the reason you chose the answer above? Another feature of bacterial endospores is ... a. formed in the sporulation process when stem cells undergo replication b. formed as a reproductive strategy for bacteria in disadvantaged conditions c. the size, shape, and position of the spores in stem cells are not fixed or can change d. the cell wall does not contain peptidoglycan, so the cell wall is stiff and resistant to heat e. can germinate or germinate when in an environment suitable for growth Are you sure about your answer? a. Sure b. Not sure	C2	Tier 2: E

The validity of VBD-Test is said to be good if the value of p is higher than α (at α = 0.05). The reliability index ranges from 0 to 1. The higher the reliability coefficient of a test (close to 1) so the higher the constancy or accuracy (Sudaryono, 2012). The level of difficulty measurement uses a P-value range between 0.0-1.0. A value of 0.0 indicates that the question is too difficult, while a P value of 1.0 indicates that the question is too easy (Sunarmi et al., 2016).

Table 3
Concept Determination Category

Category	Response Type			Score
	Tier 1	Tier 2	Tier 3	
Understand the concept	True (1)	True (1)	Sure (1)	1
Lucky guess	True (1)	True (1)	Not sure (0)	0
Misconception (false positive)	True (1)	False (0)	Sure (1)	0
Lack of knowledge	True (1)	Salah (0)	Not sure (0)	0
Misconception (false negative)	False (0)	True (1)	Sure (1)	0
Lack of knowledge	False (0)	True (1)	Not sure (0)	0
Misconception (false negative)	False (0)	False (0)	Not sure (0)	0
Lack of knowledge	False (0)	False (0)	Not sure (0)	0

Pesman & Eryilmaz (2010)

RESULTS AND DISCUSSION

There are many researches analyzed identification of misconception using other diagnostic test like two-tier diagnostic test to identify and evaluate students' scientific misconceptions in specific content areas (Treagust, 1986), using concept cartoons in diagnosing and overcoming students' misconceptions related to photosynthesis by introducing new concept cartoons to elimination of these misconceptions have been prepared and were used in class discussions (Ekici, Ekici & Aydin, 2007), and using responses to true/false (T/F) questions to identification of microbiology's misconception that know misconception without level of confidence (Briggs, Hughes, Brennan, Buchner, Horak, Amburn, McDonald, Primm, Smith, Stevens, Yung & Paustian, 2017).

The difference VBD-Test with another diagnostic test in researches before was VBD-Test using three-tier diagnostic instrument for virus and bacteria topics with three levels of question, and there is level of confidence in the third level. The results of the empirical validity of the VBD-Test include the validity with the Pearson correlation test, the reliability with spearman brown split-half method, and the level of difficulty on VBD-Test for topics of virus and bacteria can be seen in Table 4.

Table 4
Results of Empirical Validity of Questions

Topic	Empirical Validity		
	Validity	reliability	Level of difficulty
Virus	6 valid questions and 8 invalid questions	0.67 (high)	difficult 33.33%; moderate 33.33%; easy 33.33%
Bacteria	9 valid questions and 6 invalid questions	0.85 (very high)	difficult 13.33%; moderate 66.67%; easy 20%

The results of the empirical validity of the questions will be influenced by several factors such as the ability of groups or individuals, the number of samples that work on problems, and the readiness of groups or individuals in working on problems (Ratnawulan & Rusdiana, 2015). Based on the results of empirical validity regarding the validity of VBD-Test of the virus, only six questions were valid from 14 questions, while the bacteria topic showed only nine valid questions out of 15 questions. Validity functions to measure the extent to which the score difference reflects the actual differences between individuals or groups regarding the characteristics to be measured (Fraenkel & Wallen, 2009).

The reliability result about the virus was high, while the bacteria was very high. Question reliability refers to the extent to which scores produced by tests or assessment results are consistent, reliable, and replicable. The higher the reliability coefficient of a test (close to 1), the higher the constancy or accuracy (Isaacs, Zara & Herbert, 2013).

The level of difficulty of bacteria topic questions is following the proportion of questions, namely the number of moderate questions is more than the number of secure and difficult questions, while the number of easy questions and difficult questions is equal (Arifin, 2012). In contrast, the proportion of virus topic questions has the same percentage for the level of easy, moderate, and challenging questions. Questions are too easy not to stimulate someone to enhance their efforts to solve them. Conversely, questions that are too difficult will cause students to become discouraged and have no enthusiasm to try again because it is beyond their reach (Sudjana, 2004).

Identification teachers' misconceptions using VBD-Test

Based on the misconception identification of biology teachers in Malang using VBD-Test in Table 5 and Table 6, it can be seen that biology teachers still have misconceptions about virus and bacteria topics. Diagnostic tests can be used as formative tests to determine the development of teachers' concepts and measuring tools in making changes to teaching and learning (Treagust & Chui, 2011; Kruger, Won & Treagust, 2013). The reason for using three-tier diagnostic instrument in VBD-Test compared to other diagnostic tests to identify teachers' misconceptions is that almost all test

takers who work on three-tier have better results at the first level than other levels. It shows that the three-tier diagnostic instrument is the most effective measurement tool for diagnosing misconceptions compared to conventional multiple-choice and two-tier diagnostic instrument (Mubarokah, Mulyani & Indriyanti, 2018).

Identification of factors causing misconceptions in students is complicated, but the teacher is one of the factors that can cause misconceptions in students in addition to student preconceptions, textbooks, the environment, and the internet (Yates & Marek, 2014). Based on the results of the identification of misconceptions of virus and bacteria topics using VBD-Test, it can be seen that the level of misconception of biology teachers in Malang regarding virus topic is 49,189% while bacteria topic is 36,712%. The misconception of biology teacher in Malang regarding virus and bacteria topics can be qualified in the medium category because it is still in the range of 31% -60% (Utami, Agung & Bahriah, 2017).

Table 5
Results of Identification of Virus Concept of Biology Teachers in Malang

Subtopic	Item	Identification of Virus Concept				
		Understand the Concept %	Misconception		Lack of knowledge %	Lucky Guess %
			False Positive %	False Negative %		
Virus structure	1, 2, 3	53.703	3.703	29.629	12.962	0.000
Virus replication	4, 5, 6, 7	12.500	25.000	30.555	23.611	6.944
The role of virus in life	8, 9, 10, 11	31.944	16.667	26.389	16.667	6.944
The relationship between structure, replication, and the role of virus in life	12, 13, 14	35.185	9.259	55.555	14.814	3.703
Total	14	33.333	13.657	35.532	17.013	4.398

Misconception category is divided into two types, false positive and false negative. The results of the identification of misconceptions on virus and bacteria topics showed that teachers who experienced false negative were higher than teachers with false positive. Teachers who experience false positive demonstrated lack of understanding of being able to answer contents correctly on the concept being asked but cannot provide appropriate scientific reasons to strengthen their concepts, whereas teachers who experience false-negative mean only getting some information (deficiency information) or the teacher careless when choosing answers to the content of concepts or reasons (Mubarak, Susilaningsih & Cahyono, 2016; Khairaty, Taiyeb & Hartati, 2018).

Table 6
Results of Identification of Bacteria Concept of Biology Teachers in Malang

Subtopic	Item	Identification of Bacteria Concept				
		Understand the Concept %	Misconception		Lack of knowledge %	Lucky Guess %
			False Positive %	False Negative %		
Bacteria structure	15, 16, 17, 18, 19	27.778	11.111	36.667	20.000	4.444
Bacteria reproduction	20, 21, 22, 23, 24	6.667	6.667	32.222	38.889	15.556
The way of life of bacteria	25, 27	63.889	5.556	13.889	5.556	11.111
role of bacteria in life	27, 28, 29	22.222	12.962	27.778	27.778	9.259
Total	15	30.138	9.074	27.638	23.055	10.092

Biological misconceptions are spread among all Biological concepts and not only under challenging contents such as genes, photosynthesis, and respiration (Hola, 2004). Virus and bacteria topics could also be the victim of misconception. Subtopic of viruses that have the highest percentage of misconceptions is the relationship of structure, replication, and the role of virus in life, while subtopic of bacteria that have the highest percentage of misconceptions are bacteria structures. Other misconceptions that have been identified of virus and bacteria topics were vaccines must cause disease in order to work, and oxygen is required for bacteria growth and speeds up growth (Briggs et al., 2017). Many concepts in biology are interrelated, and comprehension of one concept is the key to understanding others (Tekkaya, 2002). Therefore, understanding of virus and bacteria topics is part of the biological concept needed to be learned so that teachers can learn other biological concepts (Wisudawati & Sulistyowati, 2015).

Misconceptions about virus and bacteria topics are caused by their trait of being abstract or difficult to understand (Zulfia et al., 2019). Virus and bacteria topics are included in microbiological concepts, which, according to the Fauzi & Fariantika report (2018), microbiology contains concepts that are abstract, difficult to understand, and have some unfamiliar terms. The main factor causing the misconception in teachers comes from the results of the teacher's thoughts and textbooks (Chaniarosi, 2014). If textbooks used as a guide in learning have misconceptions, then teachers who use these books as material guidelines can also experience misconceptions (Fajriana, Abdullah & Safrida, 2016; Shalihah, Mulhayayiah & Alatas, 2016).

The low level of mastery of concepts in teachers can cause misconceptions for teachers and students (Putri, Rahman & Priyandoko, 2017). Mastery of the concept of the teacher will affect the learning process of students in the classroom (Sadler & Sonnert, 2016) Teachers can experience errors in using terms or statements that are not appropriate for the interpretation of different topic when trying to present complex ideas in a way that is simplified according to the level of student thinking. How to avoid these mistakes? Teachers must be well educated to use textbooks more critically and selectively, be aware of inaccurate information in textbooks, and recognize their misconceptions (Yip, 1998; Galvin, Simmie & O'Grady, 2015).

At the beginning of learning, students already have different concepts between students, and the formation of this concept can be influenced by the environment (Ekici et al., 2007). Teachers should also pay attention to the preconceptions that students have in planning the learning process (Wisudawati & Sulistyowati, 2015). Virus and bacteria topics, including abstract concepts that are difficult to understand, so students must have high operational ability to understand abstract concepts. Teachers, as facilitators, must not have wrong understanding so as not causing misconceptions that are difficult to change in students (Ahmed, Opatola, Yahaya & Sulaiman, 2018). If the teacher is one of the causes of students' misconceptions, it is necessary to make improvements to the teacher's concept so that the teacher can make meaningful learning for students and avoid misconceptions for students (Ekici et al., 2007).

CONCLUSION

Based on the discussion, it can be concluded that the empirical validity of the questions includes validity, reliability, and the level of difficulty of the questions revealed six valid questions on the virus topic, while nine in the topic of bacteria. The reliability of the virus questions is high, while the bacteria questions are very high. The difficulty level of the virus questions is to have the same percentage between severe, moderate, and secure, while in the bacteria questions, the criterion of the moderate problem has the highest percentage. The results of the misconception identification of biology teachers in Malang using VBD-Test can be qualified in the medium category.

SUGGESTION

Further studies can identify misconceptions on biology teachers for a broader scope and topics

and manufacture products in the form of teaching materials such as modules or handouts for teachers so that teachers have guidelines on the correct concept of virus and bacteria topics. The teacher should study the topic of viruses and bacteria that have the highest misconception, namely the relationship of structure, replication, and the role of the virus in life for virus topic. In contrast, bacteria topic is the structure of bacteria.

ACKNOWLEDGMENT

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