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Research Article

Online three-tier diagnostic test to identify misconception about virus and COVID-19

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ABSTRACT

During the COVID-19 pandemic, various misinformation circulating among the public has the potential to be a source of misconceptions. This study aimed to validate the online three-tier diagnostic instrument test for Virus and COVID-19 as well as analyze the level of misconceptions experienced by students. The Treagust model is used as a reference for the instrument development process. Three public high schools providing 187 second grade students who had previously studied Virus content were involved as research respondents, The data analysis techniques used were descriptive statistics. Construct and content validity obtained from expert validation reached 89.88% and 97.12%, respectively. The results of data analysis also inform that each item was valid and the instrument was reliable. The average percentage of students who experience misconceptions was 39.96%. The average percentage of students who understand the topic correctly was 32.10%. The percentage of lucky guess reached 14.83% and students with low level of knowledge reached 13.10%. The diagnostic test as overall, was successful in detecting students' misconceptions. To overcome misconceptions and improve the quality of learning during a pandemic, biology learning must apply creative learning models, methodologies, and teaching materials.

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INTRODUCTION

The COVID-19 pandemic is very close to life and is a real threat to society. Information about COVID-19 is needed by the community so that they can know the procedures for dealing with it (Ayaz-alkaya & Mscn, 2021; Fauzi et al., 2020). Although the public has the right to receive valid information during the COVID-19 pandemic, there are barriers to accessing it. These barriers can be in the form of language aspects, the availability of news, and limited access to information. This obstacle is common in countries with low literacy levels. Unreliable information about COVID-19 has left people confused, panicked, frightened, and behaved irrationally (Fauzi et al., 2020). Fake news is easily spread through social media such as WhatsApp, Facebook, Twitter, Instagram, and YouTube. This will build a paradigm of wrong thinking and perception

about COVID-19 (Saefi et al., 2020a). Not only happens to the general public, but high school students also experience the misconception of COVID-19.

If students want to understand about COVID-19, students must have a good basic concept of Viruses in general. The concept of viruses has been studied in Biology for the first year of high school (Zulfia et al., 2019). Normally, students who have concepts about viruses should already have good knowledge about COVID-19. However, false information about massive COVID-19 spread on social media is very easily accessible to students. There is no guarantee whether students are exposed to hoax information about COVID-19 and allow conceptual changes to occur that give rise to alternative concepts or misconceptions. The increase in misconceptions about Virus and COVID-19 can also increase if online learning is not carried out optimally. Another consequence is the low level of understanding of COVID-19 which can affect the increase in the number of cases of COVID-19 infection (Fauzi et al., 2020). This condition is very dangerous for students' health if misconceptions about Virus and COVID-19 really occur (Fauzi et al., 2020; Saefi et al., 2020b).

The misconceptions experienced by students must be known immediately, because they have the potential to interfere with the concepts and knowledge they already have (Simard, 2021). An instrument is needed to detect whether students have been affected by misconceptions. Diagnostic instruments are becoming popular assessments for researchers to diagnose misconceptions in the field of Biology (Andariana et al., 2020; Arslan et al., 2012; Suwono et al., 2021). Diagnostic tests function as a data collection tool that can be used to find out students' lack of mastery of concepts (Karpudewan et al., 2015). Various types of diagnostic tests have been used in research, such as interviews, open-ended questions, multiple choice tests, and multiple-choice tests, but there are many drawbacks to using these instruments. (Raharjo et al., 2019; Suwono et al., 2021).

Interview tests are less effective for large numbers of participants, limited by time, and difficult data analysis (Jankvist & Niss, 2018). The open-ended test has shortcomings in translating and evaluating the answers of test takers (Gurel et al., 2015). Although multiple-choice tests can be used easily and quickly, respondents can answer questions by guessing and result in not being able to trace the level of mastery of the concept (Cheung & Yang, 2020). Based on the shortcomings of the previous diagnostic tests, a two-tier multiple-choice test was developed to improve and improve the quality of the test (Treagust, 1988; Yang & Sianturi, 2021). *Two-tier test provides flexibility for participants to answer and give reasons for the answers they have chosen* (Pan & Chou, 2015). The results of the study found a number of limitations of the two-tier diagnostic test (Romine et al., 2015). One of the limitations is that it provides opportunities for students to predict answers without having sufficient information.

The shortcomings of the two-tier test were corrected by adding a level of questions that served to determine the level of confidence of the respondents in answering the previous questions. The level of confidence is given a term, namely the Certainty Response Index (CRI). CRI is placed on the third level question as compensation for the weakness of the previous diagnostic test (Andariana et al., 2020; Salame & Casino, 2021). CRI or confidence level in the form of "sure" or "not sure" answer choices (Milenković et al., 2016). CRI can evaluate between students who have concepts, misconceptions, guesses, and lack of concepts (Andariana et al., 2020; Suwono et al., 2021; Taslidere, 2016). Completion of the diagnostic test into three levels of questions is called the three-tier diagnostic test (Karpudewan et al., 2015; Raharjo et al., 2019; Yunanda et al., 2019).

The three-tier diagnostic test has several advantages for diagnosing misconceptions, namely: it can be used on a wide sample range, the data is relatively easy to analyze, and allows for a wider generalization of the findings (Arslan et al., 2012). The three-tier diagnostic test is a multiple choice test that has three levels of questions: the first level is a regular multiple choice question; the second level provides an opportunity for students to choose the reasons why they choose the answers to the first level questions; and the third level asks students whether they are sure or not sure about their answers to the first and second level questions (Kirbulut & Geban, 2014; Suwono et al., 2021; Wahyono & Susetyorini, 2021). Three-tier diagnostic test also has the power to determine between concepts that have been mastered or general misconceptions.

Most studies that use three-tier diagnostic tests still use paper-based tests (Kirbulut & Geban, 2014; Suwono et al., 2021; Trotskovsky & Sabag, 2015). If this is carried out during the COVID-19 pandemic, it will increase the risk of transmission of SARS-CoV-2. Therefore, misconception researchers need to innovate in providing diagnostic tests to respondents without risking COVID-19. The use of an online survey application can be an alternative choice so that tests can be carried out, cover large samples, efficient execution time, and get data quickly. The diagnostic test based on the online survey application is the Online Three-Tier

Diagnostic Test (OT2DT). This online diagnostic test is a three-tier test assisted by Google Forms which is a free online survey application.

Research on misconceptions in the field of Biology has been widely reported in scientific publications. Some of the misconception topics that have been studied include: Cell Biology (Suwono et al., 2021), Human Circulatory System (Zhao et al., 2021), Human Anatomy and Physiology (Andariana et al., 2020), Virus-Bacteria (Zulfia et al., 2019), Protists (Yunanda et al., 2019), Photosynthesis (Haslam & Treagust, 1987), Evolution (Yates & Marek, 2014), Biochemistry (Wahyono & Susetyorini, 2021) and Environmental Science (Karpudewan et al., 2015). The latest research on the profile of COVID-19 in the field of education is health literacy and genetic literacy (Fauzi et al., 2021; Saefi et al., 2020b). However, in the current context, there is no misconception research on the topic of Viruses and COVID-19 with high school students' respondents using a three-tier diagnostic test based on an online survey application (online-three-tier diagnostic test).

The three-tier diagnostic test needs to be developed as a tool to identify students' misconceptions for the topic of Virus and COVID-19. The results of the implementation of the OT2DT can be used as information about students' misconceptions on the topic of Virus and COVID-19. The findings of this misconception research can be used as material for policy evaluation and improving the quality of the learning process during the pandemic to reduce the symptoms of misconceptions. The application of learning models, media and teaching materials can be used as alternatives to increase the level of students' conceptual understanding of the virus and COVID-19 topics.

METHOD

This research was a quantitative descriptive study that is useful for identifying misconceptions about Virus and COVID-19. The research targets were students of class XI MIPA at 16 public high schools in Padang City, West Sumatra Province who had attended Biology lessons on the topic of Viruses in the previous class. As many as 80 students of Class XI MIPA from one of the public high schools in the city of Padang were selected to be the sample for the diagnostic test trial. This is done to determine whether the test is feasible and reliable to be used as a diagnostic measure of misconceptions. Furthermore, 187 students of State Senior High School (SSHS) Class XI MIPA were selected as respondents to the implementation of the OT2DT from three public high schools in Padang City. The determination of schools as samples for the implementation of the diagnostic test is through the Stratified Random Sampling technique with the criteria for determining schools in the high, medium, and low categories based on the average value of the 2020 UTBK. Purposive Sampling technique is a method for sampling respondents to determine the level of misconceptions using OT2DT. The research was carried out from April to August 2021 which included the development of test instruments, test questions, and implementation of diagnostic tests.

This research consists of several stages, namely 1) constructing an instrument to detect misconceptions on the topic of Virus and COVID-19 which was adopted from the design of the development of the diagnostic test from Treagust (1988), 2) validating the diagnostic test instrument by assessment experts and experts on microbiology materials, 3) testing diagnostic tests, 4) analyzing test items, 5) implementing diagnostic tests to collect data from research respondents, 6) analyzing diagnostic test data to determine the level of misconceptions in each sample. The diagnostic test instrument created was applied online via Google Form. The selection of this online survey application makes it easier to collect data in a short time for many research respondents.

OT2TD as a test instrument consists of 20 items, each of which has three levels. After testing the questions, the items were analyzed with SPSS to determine the quality of the instrument from the aspects of validity, reliability, difficulty index and discriminating power. The data from the identification of misconceptions is processed by providing an answer score at each level (tier) of questions. The correct answer is given a score of 1, while the wrong answer is worth 0. The conversion results are translated to determine the category of students' level of understanding in answering questions. The category used is the category of the level of understanding of the diagnostic test answers adopted from Arslan et al. (2012), namely: 1) Strong Knowledge; 2) Lucky Guess; 3) Truly Misconception; 4) False Positive Misconceptions; 5) False Negative Misconceptions; 6) Lack of Knowledge. The whole process of interpreting diagnostic test data is processed with Microsoft Excel.

RESULTS AND DISCUSSION

When an assessment instrument is developed, the instrument must be evaluated (Amo-Salas et al., 2014). The aim is to find out whether the instrument has a good ability to collect and interpret data. Before the distribution of the OT2DT instrument trial was carried out, construct validation was first carried out by two expert lecturers, namely a microbiologist who validated the Virus and COVID-19 material content and an assessment expert who analyzed the validity of the diagnostic test instrument whose results can be seen in Table 1. Diagnostic tests must go through item analysis using four types of tests, namely: validity, reliability, discriminating power, and level of difficulty. (Cetin-Dindar & Geban, 2011). The data from the measurement of the validity and reliability of the OT2DT are listed in Table 2 and Table 3.

Table 1. The results of construct validity from the experts on OT2DT

Experts	Percentage (%)
Assessment expert	89.88
Content expert	97.12

Table 2. Validity test results on OT2DT

Question Items	R value	R table	Category
Q1	0.459	0.219	Valid
Q2	0.277	0.219	Valid
Q3	0.446	0.219	Valid
Q4	0.460	0.219	Valid
Q5	0.436	0.219	Valid
Q6	0.433	0.219	Valid
Q7	0.489	0.219	Valid
Q8	0.289	0.219	Valid
Q9	0.240	0.219	Valid
Q10	0.400	0.219	Valid
Q11	0.500	0.219	Valid
Q12	0.223	0.219	Valid
Q13	0.375	0.219	Valid
Q14	0.347	0.219	Valid
Q15	0.446	0.219	Valid
Q16	0.473	0.219	Valid
Q17	0.455	0.219	Valid
Q18	0.477	0.219	Valid
Q19	0.369	0.219	Valid
Q20	0.456	0.219	Valid

Table 3. Reliability test results on OT2DT

Cronbach's Alpha	Category	N of Items
0.728	Reliable	20

Construct validity testing of diagnostic tests by experts is important as an initial evaluation of test development. Diagnostic tests are analyzed by experts based on construction criteria and test content. The validity test uses a Likert scale 1-4 validation instrument. Based on Table 1, the assessment expert gave a score of 89.88% and the material expert stated that 97.12% of the test content was in accordance with the Virus and COVID-19 topic material. Then, the results of the validity of the test in Table 2 show that all items are categorized as valid. Furthermore, based on Table 2, the diagnostic test instrument is reliable. Based on the results of empirical validity, the items with valid and reliable values were obtained after two revisions.

The average difficulty level for all OT2DT items is 0.656 (medium) and the difference power index is 0.460 (good). Based on these results, this diagnostic test item is able to distinguish between high-ability students and low-ability students. If the question can be answered by high and low level students, then the question is in the bad category because it is easy to guess or difficult to answer (Raharjo et al., 2019). The results of the different power index are shown in Figure 1.

The discriminant index of the instrument shown in Figure 1 shows that more than half of the item items have good discriminating power. The highest percentage of the discriminatory power index was found in questions number 3 and 17 (60%), while the sufficient category (< 40%) was in questions number 2, 5, 8, 9, 12, 13, and 19. Based on these results, OT2DT was able to distinguish students with high academic level and students with low academic level (Ramdani, 2012). Thus, the diagnostic test instrument used to be able to identify students' misconceptions at different academic levels.

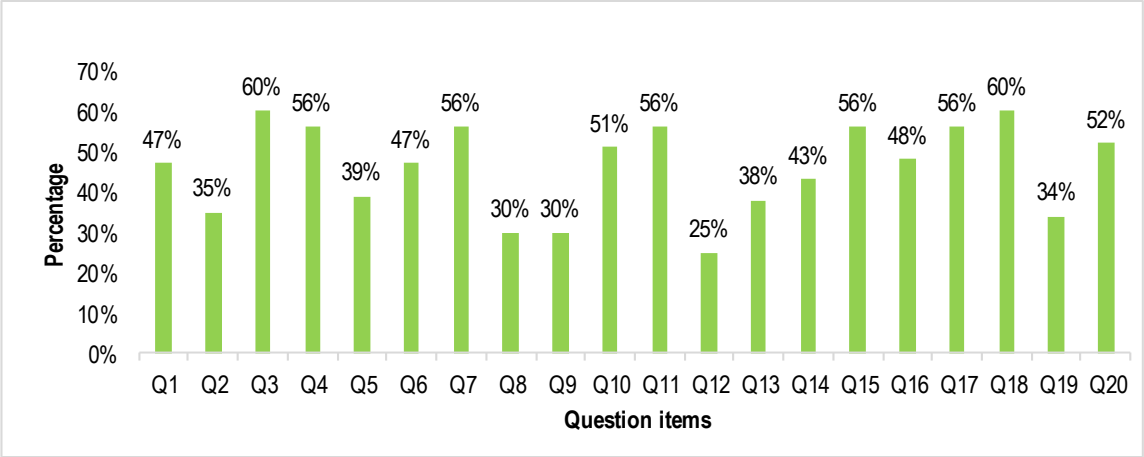

Figure 1. Discriminant power index on OT2DT instrument

Table 4. The level of difficulty of the questions on the OT2DT

Question Items	Difficulty level (P)	Category
Q1	0.738	High
Q2	0.736	High
Q3	0.538	Medium
Q4	0.225	Easy
Q5	0.675	Medium
Q6	0.788	High
Q7	0.588	Medium
Q8	0.750	High
Q9	0.600	Medium
Q10	0.263	Easy
Q11	0.550	Medium
Q12	0.663	Medium
Q13	0.600	Medium
Q14	0.650	Medium
Q15	0.625	Medium
Q16	0.788	High
Q17	0.588	Medium
Q18	0.600	Medium
Q19	0.738	High
Q20	0.713	High

In addition to discriminant power, the level of difficulty of the questions is an important factor that determines an instrument capable of measuring students' abilities. The classification of the measurement of the difficulty level of the item consists of three categories: easy level (P < 0.30), medium level (0.30 < P < 0.70), and difficult level (P> 0.70) (Isaacs, T., Zara, C., & Herbert, 2013). The results of the analysis of the difficulty level of the OT2DT questions can be seen in Table 4. The test results for the level of difficulty of the questions shown in Table 4.35% of the total OT2DT questions are in the difficult category, 55% are in the medium category, and 15% are in the easy category. The positive effect appears when the misconception detection instrument has a difficult, medium, and easy level, so that it can provide a complex thinking structure. This provides a more realistic chance of detecting misconceptions (Kaltakci-gurel et al., 2017), students' ability to solve problems (Naimnule & Corebima, 2018), a strong understanding of concepts, and an overview of the quality of learning achieved by students (Raharjo et al., 2019).

Based on the results of the OT2DT item analysis, 20 question items can be continued at the stage of identifying students' misconceptions on the topic of Viruses and COVID-19. The structure of OT2DT consists of 3 levels of questions (Treagust, 1988). Tier 1, known as Content Tier, aims to test students' content knowledge by using five answer choices. Tier 2 or Reasoning Tier aims to find out the reasons for choosing answers to the first level questions. The reasons are presented with five alternative answers consisting of one correct answer, three distractors, and one answer to an open-ended answer. Tier 3 aims to clarify the level of confidence in answering the questions of the previous level using the confidence level of "Sure" or "Not sure".

The implementation of OT2DT was carried out to 187 students of Class XI MIPA at three public high schools in the city of Padang. All answers that have been collected are examined and scored to find out the results quantitatively. The results of the scoring will determine the number of students who experience misconceptions and other variables. Interpretation of possible answers to diagnostic tests adapted from

Arslan et al. (2012). Based on these indicators, the conversion of answer scores will make it easier to determine the category of students' conceptual knowledge.

Table 5. Category interpretation of possible answers to diagnostic tests

No.	Responses			Category
	Tier 1	*Tier* 2	*Tier* 3	
1.	Correct	Correct	Correct	*Strong knowledge*
2.	Correct	Incorrect	Correct	*Misconception false positive*
3.	Incorrect	Correct	Correct	*Misconception false negative*
4.	Incorrect	Incorrect	Correct	*Truly misconception*
5.	Correct	Correct	Incorrect	*Lucky guess*
6.	Correct	Incorrect	Incorrect	*Lack of knowledge*
7.	Incorrect	Correct	Incorrect	*Lack of knowledge*
8.	Incorrect	Incorrect	Incorrect	*Lack of knowledge*

Diagnostic tests can be used as formative tests that are useful for determining the measuring instrument for the achievement of material concepts that have been absorbed during the learning process. The identification results obtained by diagnostic tests are grouped into 4 categories. For each category, the total score, average, percentage, and standard deviation are sought. The overall percentage results can be seen in Table 5.

Table 6. Percentage of student responses on the topic of Virus and COVID-19

Sub topic	Question Items	Strong knowledge	Misconception	Lucky guess	Lack of knowledge
Virus definition	Q1	44.92	29.95	17.11	8.02
Virus characteristics	Q2	36.36	32.62	21.93	9.09
	Q3	31.02	40.64	16.58	11.76
	Q4	36.90	34.22	14.44	14.44
	Q5	28.88	40.11	15.51	15.51
	Q6	30.48	36.90	16.58	16.04
Virus classification	Q7	31.55	42.25	11.23	14.97
Virus components	Q8	27.81	42.25	16.58	13.37
Virus replication	Q9	29.41	42.25	16.58	11.76
	Q10	33.16	48.13	9.09	9.63
	Q11	23.53	44.92	15.51	16.04
The role of viruses	Q12	25.13	55.61	11.76	7.49
	Q13	28.88	45.45	17.11	8.56
COVID-19	Q14	27.62	44.20	11.05	17.13
	Q15	38.50	44.39	9.09	8.02
	Q16	29.95	42.78	10.70	16.58
	Q17	32.62	41.18	13.90	12.30
COVID-19 Vaccine	Q18	33.69	35.83	15.51	14.97
	Q19	41.71	28.34	10.70	19.25
	Q20	29.95	27.27	25.67	17.11
Mean		32.10	39.96	14.83	13.10

Based on Table 5, the level of student misconceptions about Virus and COVID-19 is high. This is evidenced by the 20 OT2DT questions that have a high percentage of misconceptions compared to other categories. This is evidenced by the acquisition of 39.96% for the "misconception" category, 14.83% is the acquisition for the "lucky guess" category, 13.10% is the percentage result for the "lack of knowledge" category, and 32.10% is the percentage "strong knowledge" category.

The highest percentage in the "strong knowledge" category was found in the "virus definition" sub-material (44.92%), while the lowest was in the "virus replication" sub-material (25.53%). The "lucky guess" category, in the "COVID-19 vaccine" sub-material, the highest percentage (25.67%), while in the "virus replication" and "COVID-19" sub-material the lowest percentage (9.09%). The highest percentage for the "lack of knowledge" category is in the "COVID-19 vaccine" sub-material of 19.25%, while the lowest percentage is in the "role of virus" sub-material of 7.49%. Especially for the "all of misconceptions" category, the highest percentage gain was in the "role of virus" sub-material of 55.61%, while the sub-material with the lowest percentage acquisition was "COVID-19 vaccine" (27.27%).

Figure 2 shows a diagram of the percentage of students who answered the OT2DT questions correctly at each tier. FT (first tier) is a question at the first level that tests the level of understanding of the concept of Virus and COVID-19. The percentage of students who answered correctly on the first level questions was 12%. So it can be seen that the level of students' understanding (content knowledge) of the Virus and COVID-19 material is relatively low because the first level questions are dominated by wrong answer choices.

ST (second tier) is a second level question that plays a role in determining the reason for the answer chosen on the first level question. Based on the percentage shown in the diagram, 26% of students chose the correct answer as a reason to strengthen the choice of answers to the first level questions. TT (third tier) is a third level question which is a reaffirmation of answers at the first and second levels. The affirmation is by choosing between sure or not sure. The percentage level of confidence in the answers at the third level is 18%. So, if the whole is combined into all levels of questions (all of tier) then the percentage of students answering the answer choice options is 44%. Students who became OT2DT respondents managed to choose the correct answer 44%, while the rest chose the wrong answer.

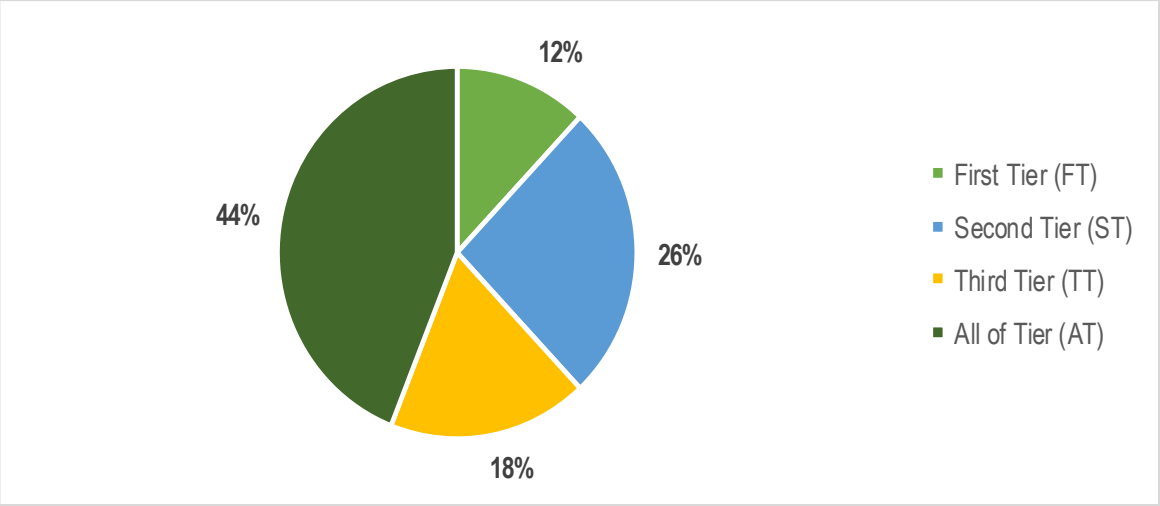

Figure 2. Percentage diagram of students' correct answers

According to the identification category of diagnostic test results from Arslan et al., (2012). The category of misconceptions is divided into three types, namely: True Misconception, False Positive Misconception, and False Negative Misconception. The percentage of each category of misconceptions can be seen in Figure 3.

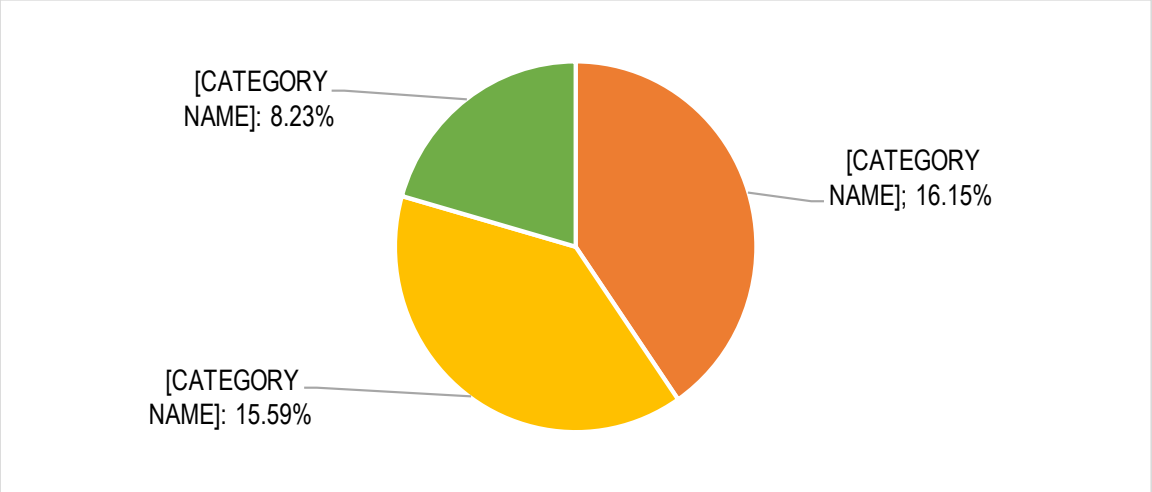

Figure 3. Misconception category diagram

Figure 3 shows the highest percentage among the three categories of misconceptions is Truly Misconception at 16.15%. Then followed by Misconception False Positive with a percentage of 15.59%. The final percentage for the Misconception False Negative category was 8.23%. It can be seen that students experience true misconceptions about Virus and COVID-19 material based on the OT2DT instrument, because students choose wrong, wrong, and right answers so that the final conclusion based on the indicator is Truly Misconception. The misconception categories "False Positive" and "False Negative" aim to clarify the status of misconceptions, because previous studies reported that some students in the misconception category answered the questions correctly. This gives rise to a false interpretation of the status of the misconception.

The percentage of False Positive is higher than False Negative, so it is known that students who answered the questions correctly at the first level were more likely to answer the questions correctly at the second level. False positives and false negatives provide a clearer interpretation of misconception research. Determination of question items that are able to display higher misconception results compared to other items can be seen in Figure 4.

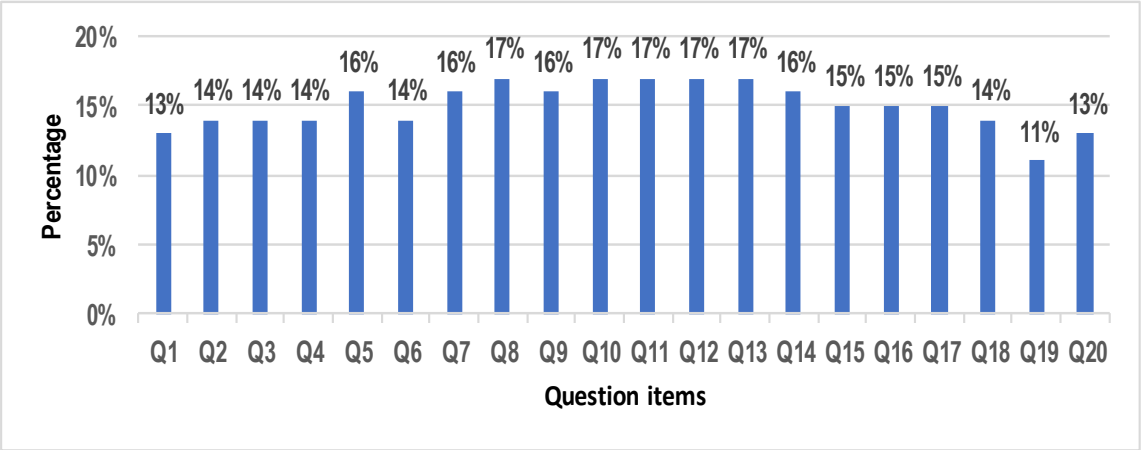

Figure 4. Percentage of correlation between levels of misconception

The percentage of correlation between items with misconceptions is shown in Figure 4. Analysis of the OT2DT questions was carried out to specifically identify sub-materials where there was a misunderstanding of the concept of Virus and COVID-19. The prevalence of misconceptions related to the percentage of misconceptions throughout the level (M-AT) below 15% is assumed to be the margin of error of this diagnostic test. Figure 4 assumes that 40% of the item items do not reflect misconceptions, while 60% of the item items show misconceptions. Items that show symptoms of misconceptions are Q5 (16%), Q7 (16%), Q8 (17%), Q9 (16%), Q10 (17%), Q11 (17%), Q12 (17%), Q13 (17%), Q14 (16%), Q15 (15%), Q16 (15%), and Q17 (15%). Each item that is able to identify misconceptions must have a high level of confidence in the respondent's answer choices. Figure 5 shows the percentage level of confidence (level of confidence).

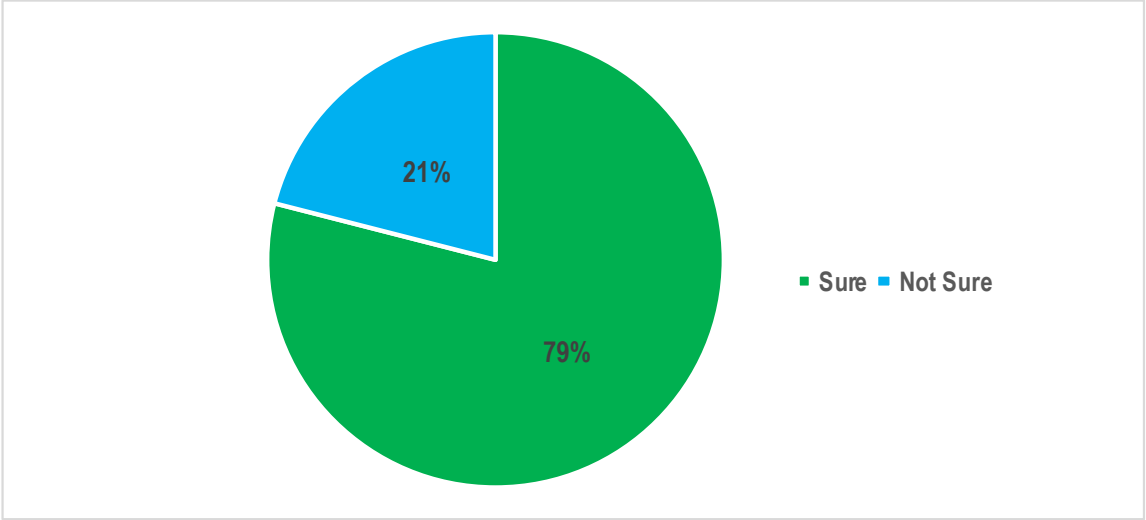

Figure 5. Percentage level of confidence in answering questions

The level of confidence in the OT2DT is very important to measure and know, because it determines how confident the respondents are in choosing the answers to the first and second level questions. The level of confidence in OT2DT lies in the third level question (tier 3). This category is very crucial because it is an important part in interpreting the conceptual categories of students' knowledge. Based on Figure 5 shown in the diagram, 79% of students answered the questions with full confidence, while 21% were unsure of the answers to the previous level questions. The level of confidence (level of confidence) with a high percentage will minimize the chances of the emergence of answers that are guessed by students (lucky guess) and

students who answer incorrectly for all levels of questions (lack of knowledge). So that the analysis of conceptual mastery is more specific to indicators of strong knowledge and misconceptions. A high level of trust has an influence on a person's response to new information. Trusting information excessively will inhibit the repetition of concepts when the material is re-taught at an advanced level (Andariana et al., 2020). Disproportionate self-confidence makes students believe that their version of the concept understanding is the most correct, but in fact this is not the case. Therefore, students need to raise awareness of the inaccuracy of their assessment of a concept.

The results of the study, based on the data that have been described previously, show that class XI SSHS students have misconceptions about Virus and COVID-19 with a fairly high category achievement. The data were obtained from valid, reliable, good discriminating instruments, and moderate difficulty levels. This statement is in accordance with previous studies which stated that the quality of the assessment instrument must be valid and reliable so as to produce quality data and in accordance with the objectives to be studied. (Taherdoost, 2018). Misconceptions can be detected if the test instrument is valid and can be trusted (Ghazali, 2016). This finding is based on a valid and reliable OT2DT capable of diagnosing high school students' misconceptions. This is in line with previous studies which provide a strong recommendation that the three-tier test is an instrument that has accuracy in tracing misconceptions that occur in students (Arslan et al., 2012; Kaltakci-gurel et al., 2017).

Misconceptions need to be detected quickly. Therefore, a method is needed to identify the symptoms of misconceptions in students. There are several ways commonly used by researchers to explore misconceptions. However, an effective way to use is a diagnostic test. Diagnostic tests are formative assessments to determine the level of mastery of concepts and measuring tools for competency achievement, the results of which are used as reflection material for further learning (Anggoro et al., 2019). Multiple-choice diagnostic tests are mostly used by researchers to diagnose misconceptions, but this instrument is not able to distinguish whether students have or do not experience misconceptions. Diagnostic tests continued to undergo transformation, in the end a three-tier diagnostic test instrument was found, namely the three-tier diagnostic test. This test can not only find out whether the student answered the wrong questions due to misunderstandings, but also be able to distinguish between misunderstandings caused by lack of knowledge (Machová & Ehler, 2021).

Misconceptions in Biology have the potential to occur in all Biology concepts not only to the concepts of genetics, respiration, cell biology, the circulatory system, human anatomy, physiology and biochemistry. (Septiyani & Nanto, 2021; Tekkaya, 2002; Yates & Marek, 2014). The topic of Virus and COVID-19 becomes an urgency in the current condition, because it is directly related to the environment and daily life that is on standby with the pandemic situation. Based on the results of the identification of misconceptions, the percentage of misconceptions category is still the highest gain compared to other indicators. This is because students have corrected the wrong concept from the start, so students fail to choose the correct statement to answer the reason for choosing the answer to the previous question. Partial understanding shows the condition when students are only able to answer the first level questions correctly but cannot choose the correct reasons for the second level questions (Trotskovsky & Sabag, 2015). The findings of other researchers also explained that students who tend to only memorize the results of information without reviewing the truth, will have difficulty understanding and synthesizing important concepts (Yang & Sianturi, 2021). Therefore, students' knowledge and understanding of concepts need to be improved through early detection of misconceptions, not only as an achievement of minimal competence in learning, but knowledge that can be implemented for themselves and the environment in order to prevent themselves from being infected with SARS-CoV-2.

Overall, these findings open up options for action for Biology teachers and education policy makers to better design learning about Virus and COVID-19 topics. The OT2DT provides an alternative formative assessment as a reflection of learning. This diagnostic test is recommended to highlight and evaluate misconceptions in students (Suwono et al., 2021). Using OT2DT as a diagnostic test, teachers can find out illustrations of students' knowledge levels, as well as misconceptions about the concepts they have taught during learning activities (Treagust, 2006). If this test is carried out as a final evaluation test of learning, it will increase students' attention to focus on completing their assignments seriously (Cheung & Yang, 2020). The results look more accurate to determine whether students have misconceptions or have enough concepts. In order for the results to be more real and specific, diagnostic tests can be carried out at the beginning (pre-test) and at the end (post-test), then it can also be tested with a difference in the duration of the test which is likely to be new findings on the results of misconception from the aspect of different review (Karpudewan et

al., 2015). After the results of the misconceptions are known, the important step is to determine the important concepts that are of concern for improvement.

Biology teachers can evaluate the learning process for one semester to design new learning activities to prevent wrong concepts from repeating themselves to students. Teachers can try to apply a learning model that matches the characteristics of the Virus and COVID-19 material to anticipate misconceptions. However, because learning activities are still unstable between online learning, face-to-face learning or blended learning. The development of innovative online-based learning models combined with methods, media, and teaching materials needs to be formulated for further studies. The implementation of problem-based learning models assisted by electronic modules can be an alternative for further research to overcome misconceptions about Virus and COVID-19. Regarding OT2DT, it is necessary to evaluate to improve the quality of diagnostic test instruments so that the results are more accurate. Option to add an open-ended question answer column on the diagnostic test instrument to find out the reasons why students choose answers. After that, adding questions to four levels (four-tier) or five levels (five-tier) in order to increase the quality level of the measurement tool for detecting misconceptions. In addition, researchers can conduct interviews with respondents to get alternative ideas from their explanations. In the end, the most important thing is that the quality of the diagnostic test instrument must be improved, so that the results can be more accurate in diagnosing students' misconceptions.

CONCLUSION

The OT2DT is a valid and reliable diagnostic test instrument to be used to identify high school students' misconceptions about Virus and COVID-19. The results of this study indicate that 32.10% of students are included in the category of strong knowledge, 39.96% have misconceptions, 14.83% choose to guess the answer (lucky guess), and 13.10% have little knowledge about the topic being tested (lack of knowledge). So, it is known that high school students have misconceptions about the topic of Virus and COVID-19.

The OT2DT is highly recommended to be used as a diagnostic tool for high school students' misconceptions. The results of misconception research can be used as evaluation material in designing better learning. The application of interactive learning models, media, and teaching materials can be used as a solution to correct students' misconceptions. As a continuation of the research, diagnostic tests can be evaluated by adding several levels of questions, adding answers to open-ended questions, and interviewing respondents so that this test can better and accurately diagnose misconceptions.

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