Students' understanding in airborne transmission of SARS-CoV-2 by dynamic fluid perspective using Structure of Observed Learning Outcomes (SOLO) taxonomy

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ABSTRACT

Online learning imposed by government as an impact of the COVID-19 pandemic affected students' ability to understand the authentic problem. Authentic problem used to train students' ability to apply their knowledge in physics. This research mainly discusses about the students' understanding of the authentic problem that is SARS-CoV-2 airborne transmission using the SOLO taxonomy. This research used a descriptive qualitative approach using eight questions related to SARS-CoV-2 airborne transmission. Data collected from 36 students in XI-Sciences grade at one of public school in Surabaya via online survey platform and analyzed by calculating the percentage of student's understanding level for each given question. The result shown that 59% student included in pre-structural level, 19% in uni-structural level, 10% in multi-structural level, 3% in relational level, and 10% in extended-abstract level. Majority of students failed to complete the answer and choose to answer that refers to their experiences.

Keywords: SARS-CoV-2, SOLO taxonomy, understanding level

INTRODUCTION

The 21st-century learning model emphasizes teachers and students to provide examples of authentic problems (Ramadhani & Ermawati, 2021). Authentic learning allows students to explore and discuss relevant issues (Restu & Lukitasari, 2019; Wulansari & Admoko, 2021). One of the authentic problems that are included in the very urgent category is the Coronavirus Disease 2019 (COVID-19) pandemic caused by SARS-CoV-2 (WHO, 2020).

COVID-19 had a significant impact on human life, especially in the world of education that change the face-to-face learning system in schools into online learning (Dwikoranto et al., 2021; Mahfudin et al., 2020).

Online learning as imposed by the government forces students to adapt in improving their understanding of this learning model. However, some studies reveal that this learning is not effective. Some of the contributing factors are the students' lack of ability to use gadgets for learning, limited internet quota and

uncertain learning time (Anugrahana, 2020; Azzahra, 2020). This is also supported by an indication that students feel a little useful in learning (Sari, D. P., & Sutapa, 2020). In an online learning Physics, students find it increasingly difficult to understand the lesson when compared to face-to-face learning (Haqiqi et al., 2021; Haryadi & Jannah, 2020). Online learning also affects student learning outcomes. Several studies have shown that student learning outcomes during online learning are better than face-to-face learning. This depends on the ability and accessibility of students to get better quality learning media (Handayani, 2020; Suryana et al., 2021).

Based on previous research, it can be understood that students' understanding during online learning are lacking. There is a need for testing students' levels of understanding during online learning. The measurement of the expected levels of understanding uses authentic problems, so that the measurements given can determine the students' levels of understanding during the pandemic. In Physics perspective, the spread of SARS-CoV-2 can be an authentic problem in fluid dynamic materials (Seminara et al., 2020; Setti et al., 2020; Yu et al., 2020). This material has the scope of learning fluid characteristics, starting from liquid fluids, gas fluids, as well as fluid dynamics applications in daily basis, making it suitable to introduce SARS-CoV-2 transmission problems while learning Physics (Chu et al., 2020). In addition, the reason of choosing Dynamic Fluids test material is because this material is taught in class XI Science in first semesters, which is at that time students have an online learning model (Widayoko, 2021).

Students' levels of understanding in solving authentic problems can be known by using the Taxonomy Structure of Observed Learning Outcomes (SOLO). The SOLO taxonomy was developed in 1982 by Biggs and Collins to classify students' understanding levels into five levels, namely pre-structural, uni-structural, multi-structural, relational, and extended abstract (Hartanti et al., 2021). SOLO taxonomy has a lot of revised version, thus this research used latest of SOLO taxonomy level adapted by Helly (2018).

Table 1. SOLO taxonomy levels (Biggs & Collis, 1982; Helly, 2018).

Level	Description
Pre-Structural	Student does not have any kind of understanding, no ability to explain reason and causes. No ability to develop argument.
Uni-Structural	Student can deal with one single aspect and make obvious connections. Satisfactory ability to explain reason and causes. Development of argument is not logical.
Multi-Structural	Student can deal with several aspects but disconnected. Good ability to explain reasons and causes. Can provide argument but not fully convincing
Relational	Student understand relation between aspects. Very good ability to explain reasons and causes. Very good development of argument.
Extended Abstract	Student generalize structure beyond given information. Excellent ability to explain reasons and causes. Excellent development of argument.

The SOLO Taxonomy is commonly used by researchers to analyze students' levels of understanding. Some of them are to measure the students' levels of understanding in inquiry-based learning (Damopolii et al., 2020). Compiling indicators of understanding and physics concepts in general (Pratiwi et al., 2015; Ramlo, 2019). Measuring students' levels of understanding in geometry problems (Agustinsa et al., 2021) and measure students' levels of thinking in solving parabolic motion problems (Hartanti et al., 2021). Based on these results, it can be understood that the

SOLO Taxonomy can be used as a simple measuring instrument in determining the levels of difficulty from the questions.

The type of taxonomy that is well-known and widely used in Indonesia is Bloom's taxonomy. (Blyth et al., 1966) developed a continuum for categorizing questions and thinking responses (Amalia & Wahyuni, 2020). Bloom's taxonomy has been revised and is used in most high school syllabuses in Indonesia, and is also widely used in science education assessment environments (Desiriah & Setyarsih, 2021; Erniyanti et al., 2020). However, Bloom's taxonomy does not show the criteria for measuring and evaluating learning outcomes that allow feedback in the assessment of essay questions. In contrast to the SOLO Taxonomy which has a special classification that can categorize students' levels of understanding which can be seen from the answers given by students when answering essay questions.

Based on these problems, this research aims to identify students' levels of understanding of SARS-CoV-2 airborne transmission in the Fluid Dynamic perspective at five levels of SOLO taxonomy. Through this research, students' understanding was identified according to the Polya procedure with adjustments to the criteria for questions in the SOLO Taxonomy. This research uses the assumption that during an online learning, students have the same learning experience in each class.

RESEARCH METHODS

Based on the research aim that has explained in the introduction, the suitable type of research is survey without a qualitative descriptive comparison group. It is because this research mapping students' ability to understand authentic problems.

This research was conducted in one of the Public High Schools in the Western area of Surabaya. Respondents consisted of 36 students of class XI Science who had received Dynamic Fluids material during an online learning. This research uses an instrument consist of 8 questions describing the air transmission of SARS-CoV-2 in the context of fluid dynamics which refers to the indicators of understanding in the SOLO Taxonomy. Biggs & Collis (1982) explained that mastery of concepts using the SOLO taxonomy based on student responses, including pre-structural level (P), uni-structural level (U), multi-structural level (M), relational level (R), and extended abstract level (EA). The questions given in this research aimed to measure students' understanding of the authentic problem of SARS-CoV-2 airborne transmission using the SOLO Taxonomy. The questions given are adapted from the results of validated research on SARS-CoV-2 airborne transmission and validated Physics books.

Table 2. One of the 8 questions written in the questionnaire form.

Indicator	Question
Based on several information given about the difference of diameter of droplets and aerosols, Student able to describe the relation between particles' diameter and Stokes Force.	SARS-CoV-2 transmitted both via nasal droplets and nasal aerosols. It is known that droplet has a larger size in diameter than aerosols. This resulted difference of both droplets and aerosols in experiencing the Stokes Force. Based on given information, which particles experienced significant Stokes Force?

The instrument that consists of 8 questions was distributed through an online platform named Microsoft Form. Then the result was obtained from students' responses in answering the tests given in the form of description answers. The result was analyzed by calculating the percentage of student's level of understanding for each given question. The percentage of students' levels of understanding scores can be calculated using the Equation (1).

$$I_i = \frac{N_i}{M} \times 100\% \qquad (1)$$

where I_i is the percentage of students' understanding for level i, N_i is the number of students in a level i, M is the number of respondents (students), and i is the level in the SOLO taxonomy that consist of P, U, M, R, AE.

RESULTS AND DISCUSSION

This research mainly discussed about the students' levels understanding of the authentic problem that is SARS-CoV-2 airborne transmission using the SOLO taxonomy. The percentage of students' level of understanding can be seen from each question and the total percentage presented in the Table 3:

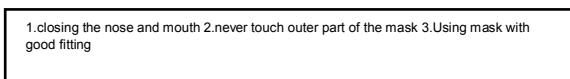**Table 3.** The percentage of students' level of understanding in SOLO Taxonomy

Q	P		U		M		R		EA	
	n	%	n	%	n	%	n	%	n	%
1	17	50	16	47	0	0	0	0	1	3
2	23	68	6	18	2	6	2	6	1	3
3	29	85	2	6	0	0	2	6	1	3
4	18	53	5	15	7	21	0	0	4	12
5	24	71	2	6	4	12	0	0	4	12
6	23	68	2	6	1	3	2	6	6	18
7	5	15	14	41	9	26	2	6	4	12
8	21	62	4	12	3	9	1	3	5	15
Σ	20	59	6	19	3	10	1	3	3	10

Based on Table 3, it can be determined that the student's understanding of the SARS-CoV-2 airborne transmission as the authentic problem at the pre-structural level (P) was 59%. It is shown that the majority of students are still at the pre-structural level. The answers given by students at this level indicate that students have difficulty understanding the problems given, using answers that refer to experiences that are not related to the problem. This is in accordance with research conducted by and also by (Hartanti et al., 2021). In addition, at the pre-structural level there are students who do not answer or provide random answers to just fulfilling the answer without considering it at all.

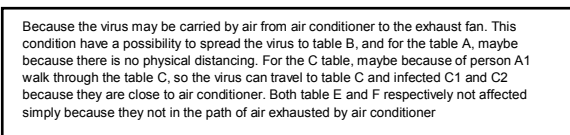The student's level of understanding at the uni-structural level (U) reached 19% where at this level students can answer questions using one of the information provided in the problem, but no reasons or supporting arguments are mentioned in the answer. This is as mentioned in research by Rachman et al., (2018) and also by Hartanti et al., (2021) which state that at the uni-structural level, students can use information as the basis for answer the question.

For the multi-structural level (M), 10% of the students reach this level where they can answer using two or more information provided in the problem and also using quite logical reasons, but there are no arguments that explain the relationship between information. This is in line with research of Rachman et al., (2018) which states that at this level, students can use more than one information in answering the question. In addition, the answers given by students is in the form of a list, which shows that students can use more than one information provided, but they are not interconnected with each other just as shown in Figure 1.

1.closing the nose and mouth 2.never touch outer part of the mask 3.Using mask with good fitting

Figure 1. Student's answer that included in multi-structural level

Students that reach relational level (R) are just 3% of all of the students. At the relational level, students can provide interrelationships between information, so that all the information available in the question can be used as a conclusion to the answer. The reasons and arguments given by students are logical and in accordance with the context of the problem. Biggs & Collis, (1982) explains that if students can reach the relational level, then students have the ability to compare, relate, analyze, apply, and explain theories in causal relationships. This is evidenced by the answers given by students as shown in Figure 2.

Because the virus may be carried by air from air conditioner to the exhaust fan. This condition have a possibility to spread the virus to table B, and for the table A, maybe because there is no physical distancing. For the C table, maybe because of person A1 walk through the table C, so the virus can travel to table C and infected C1 and C2 because they are close to air conditioner. Both table E and F respectively not affected simply because they not in the path of air exhausted by air conditioner

Figure 2. Student's answer that included in relational level

Meanwhile, students' level of understanding for the extended abstract (EA) reaches 10%. Students with this understanding level have the same answer criteria as the relational level, but with the addition of information about concepts that are not contained in the questions to become an argument. This additional argument is evidence that students can give answers from different perspectives, such as student's answers as presents in Figure 3.

The factor that caused distancing in outdoors need to be further away than in the indoors because there is a lot activity in outdoors, like sport that cause more heavy breathing in some cases than indoor activities, and also sport need a lot of fresh air, so people encouraged to not wear a mask to avoid heavy breathing and injuries. In pandemic perspective, this will increase the risk of getting infected. And last but not least, outdoor activities often involve a huge crowd, like some concerts and social activities, compared to indoor activities like office that easy to regulate physical distancing.

Figure 3. Student's answer that included in extended abstract level

(Biggs & Collis, 1982) describes students' understanding in an extended abstract level is when the students can provide a general picture beyond the information provided. Students can provide answers through a different perspective with the perspective of the answer expected in the question (still in the context of the correct answer). The description is in accordance with the result of this research.

Table 3 also provides a random difference in the percentage of students' understanding for each level. It can be interpreted those students show different understandings for different tasks and it meets (Biggs & Collis, 1982) opinion which states that each level of student understanding in responding to answers is different.

CONCLUSION

Based on the data obtained in the results and discussion, it can be concluded that the percentage of students' understanding of the authentic problem of SARS-CoV-2 airborne spread in a dynamic fluid perspective is 59% of students included in pre-structural level, 19% of students are in uni-structural level, 10% of students included in the multi-structural level, 3% of students included in the relational level and 10% of students included in the extended abstract level. This result can be interpreted that majority of students fail to complete the answer. Students rather choose to answer that refers to their own experiences, without using their knowledge in dynamic fluid. It can be understood that teachers need to guide their students by providing authentic problems during learning so that students can understand the concepts of physics and its relationships on the daily basis.

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