Identification misconceptions using Movement and Circulatory System Diagnostic Test (MCSD-Test) in XI class SMA/MA in East Java

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Abstract. Movement and circulatory system discusses biological phenomena that occur in the body. Both materials are classified as abstract because they cannot be observed directly. Abstract material will apply to students. Difficulty understanding concepts can lead to misconceptions. Misconceptions can hinder students from constructing scientific concepts so that they can hinder the learning process. This is what makes misconception messages important. This study used a diagnostic test for the movement and circulatory systems to identify misconceptions. Each question on this test consists of three levels. One of the three-tier instruments can differentiate between students who lack knowledge and those experiencing misconceptions. This research was conducted in 4 regions in East Java Province, namely Lamongan Regency, Kediri Regency, Trenggalek Regency and Malang City. The research sample was 669 class XI students who were taken from 12 schools in 4 regions. The results showed that students who experienced misconceptions on the material of the movement system were 17.05% and the circulatory system was 31.38%. Factors are causing student misconceptions, especially because the teaching materials used by students have misconceptions. Suggestions for further research are (a) to examine misconceptions on other biological materials (b) to further analyze the causes of misconceptions, and (c) to identify misconceptions of the Biology teacher.

1. Introduction
The system of movement and the circulatory system includes abstract material in biology learning. Both discussed the biological processes that occur in the human body. That matter abstract, high complexity, the number of organs involved and mutually continuous processes can cause students to have difficulty understanding this material [1]. This can trigger misconceptions in students [2]. Misconception is a false belief, usually created by experience, in understanding an idea, object, or phenomenon [3]. Another definition of misconception is the perception of a phenomenon that occurs in the real world that is not compatible with the scientific explanation of the phenomenon [4]. The causes of misconceptions in students can be in the form of text books that students read, students 'understanding that is brought before starting learning, students' translation of a phenomenon, and teacher explanations [5]. Misconception is a problem that needs to be reduced because if misconception is allowed, it can become an obstacle for students in learning the next material [6]. According to Khotimah, misconception is an obstacle to the construction process of scientific conceptions, especially in science learning [7]. If students experience misconceptions, it will be difficult to correct them. This is evidenced by a number of studies regarding misconceptions that misconceptions remain stable among students at primary,
secondary, and tertiary levels [8]. If students use the wrong concept in their daily life, it will be dangerous. Identification of misconceptions can be used by the teacher to detect misconceptions in students. This what makes it important to identify misconceptions. One way that can be used to identify student misconceptions is by using a three-tier diagnostic test. The three-tier diagnostic instrument consists of three levels, namely the first level students are asked to choose the correct answer. The second level students were asked to choose the reason for their answers at the first level, and the third level in the form of the choice confidence level at the first level and the second level [9]. The three-tier diagnostic test is more accurate in exposing people's misconceptions because it takes into account answers and levels of confidence [10]. Through student answers and level of confidence, a three-tier diagnostic test can differentiate between students who have misconceptions and lack of knowledge [11].

2. Method

2.1. Participants
This research was conducted in twelve senior high schools in East Java, namely Trenggalek, Kediri, Malang and Lamongan districts with 669 research subjects of class XI IPA students. Each school was sampled as many as two classes. The research was conducted in the even semester of the 2020-2021 school year. The test is given after the students have finished receiving the learning materials for the movement system and circulatory system. The time provided to work on the questions is 90 minutes.

2.2. Procedure
The misconception diagnostic instrument was developed by adapting previous research by Treagust (1988) [12]. The detailed research stages are as follows.

2.2.1. Defining content. At this stage, the boundaries of the material concept of the movement system and the circulatory system are determined to be identified. The determination of the concept is carried out based on the basic curriculum standards applicable to class XI. In addition, the concepts compiled refer to relevant literature and are presented in the form of a concept map. The concept that has been prepared is a framework for making an open-ended test grid.

2.2.2. Collecting descriptions of student misconceptions. Student misconceptions were obtained through an open-ended test. The open-ended test was given to 115 students to obtain information on students' understanding of the content of the movement system and circulatory system material. The open-ended test is a multiple choice question with five answer options accompanied by an open reason column for the answers that have been selected. The open-ended test that is structured also considers the results of previous research related to the concept of material that has many misconceptions. The results of the open-ended test form the basis for constructing a two tier before developing a three-tier diagnostic test which in this study is referred to as the MCSD-Test.

2.2.3. Developing the Movement and Circulatory System Diagnostic Test (MCSD-Test). This stage begins with compiling a two-tier test, namely the first tier contains multiple choice questions with five answer options and the second tier contains the choice of reasons for the first tier answer. The second tier is the result of the answers collected when giving open-ended tests to students. Then, a Movement and Circulatory System Diagnostic Test (MCSD-Test) was developed which contains three levels, namely a third tier which involves the level of confidence (sure or not sure) of students on the answers that have been selected in the first and second tiers. The diagnostic test instrument framework is arranged in the form of a question grid to illustrate that the concepts presented in the test items are proportional. Then, the three-tier diagnostic test is validated by material experts and assessment experts. In addition, a limited scale trial was also carried out on 127 students to measure the empirical validity of the items.
2.3. Instrument

Misconceptions identification data were obtained using the Movement and Circulatory System Diagnostic Tests (MCSD-Test) instrument. The MCSD-Test consists of 15 questions on the movement system and 15 questions on the topic of the circulatory system. Example questions MCSD-Test can be seen on Table 1.

| Material          | Subtopic                  | Questions                                                                 |
|-------------------|---------------------------|---------------------------------------------------------------------------|
| The Movement      | Striated muscles          | Our hands can be moved because of the muscles that are attached to the bones, this is because bones are passive means of movement and muscles are active means of motion. The exact statement below is .... |
| System            |                           | a. On the hands the smooth muscles relax                                  |
|                   |                           | b. Hands can move tirelessly                                               |
|                   |                           | c. Smooth muscles cause the hands to work consciously                      |
|                   |                           | d. The movement of the hands due to the contraction of the striated muscles|
|                   |                           | e. Move hands according to brain control unconsciously                    |
|                   |                           | The reason for my answer:                                                 |
|                   |                           | a. Smooth muscles are attached to the apparatus of movement               |
|                   |                           | b. The types of muscles in the hands work unconsciously                   |
|                   |                           | c. Smooth muscles work under the control of the brain                     |
|                   |                           | d. Smooth muscle has thick and thin filaments                             |
|                   |                           | e. Striated muscles attach to the limb bones & are able to contract       |
|                   | Circulatory system        | Look at the picture below!                                                |
| disorders         |                           | Based on the picture above, generally the cause of Andi's feet like that because .... |
|                   |                           | a. failure of the blood clotting process                                  |
|                   |                           | b. blockage of the coronary arteries                                      |
|                   |                           | c. lack of red blood cells d. dilation of veins                           |
|                   |                           | e. frequent smoking                                                       |
|                   |                           | The reason for my answer is because Andi experienced ....                 |
|                   |                           | a. Varicose veins due to chronic inflammation of the muscles              |
|                   |                           | b. Varicose veins due to the buildup of blood in the veins                |
|                   |                           | c. Varicose veins are caused by a buildup of purine levels in the body d. |
|                   |                           | Gout due to eating lots of foods high in sugar e. Uric acid due to        |
|                   |                           | cholesterol buildup                                                      |

2.4. Analysis

The data analysis technique was carried out by analyzing the empirical validity of the MCSD-Test using the Product Moment correlation formula. While the correlation test reliability test was carried out using the Alpha Cronbach formula. The calculation of validity and reliability tests uses software assistance. The results of the analysis of the identification of student misconceptions using the MCSD-Test based on the identification category of misconceptions [13].
3. Results and Discussion
This study explains the identification of misconceptions to 669 SMA / MA students in East Java on the material of movement systems and circulatory systems. Identify these misconceptions using MCSD-Test. MCSD-Test is a three-tier diagnostic test. The first tier contains multiple choice questions, the second tier contains the reasons for the answer, and the third tier contains the confidence level. This third level is used to distinguish students' wrong answers, due to lack of knowledge and misconceptions [14]. Diagnostic tests are tested for validity and reliability. The results of the validity test show that the 30 questions used are valid with a reliability of 0.8, this indicates that the questions have high reliability [15].

### Table 2. Results of the concept identification of the movement system

| Sub Topic                         | Item | Understand The Concept | False Positive | False Negative | Misconception | Lack of knowledge | Guess |
|-----------------------------------|------|------------------------|----------------|----------------|---------------|------------------|-------|
| Type of human skeleton function   | 1,2  | 24.14%                 | 31.18%         | 10.69%         | 16.65%        | 15.47%           | 1.89% |
| Skeleton structure                | 3,4  | 28.77%                 | 13.75%         | 9.04%          | 21.82%        | 24.81%           | 1.78% |
| Bone structure                    | 5    | 43.12%                 | 16.14%         | 6.43%          | 13.60%        | 16.14%           | 4.48% |
| Type of ossification              | 6    | 6.88%                  | 18.54%         | 36.32%         | 25.41%        | 10.76%           | 2.10% |
| Kinds of bone shape              | 7    | 45.44%                 | 18.09%         | 10.16%         | 10.01%        | 12.41%           | 3.89% |
| Types of joints                   | 8,9  | 51.05%                 | 21.30%         | 6.20%          | 7.10%         | 11.73%           | 2.62% |
| Striated muscles                  | 10,11| 21.52%                 | 9.04%          | 11.14%         | 13.00%        | 42.07%           | 3.21% |
| The working nature of muscles     | 12   | 48.43%                 | 19.13%         | 8.52%          | 8.52%         | 11.06%           | 4.33% |
| Disorders of the movement system  | 13,14,15 | 31.83%             | 8.57%          | 7.87%          | 27.53%        | 20.08%           | 4.09% |
| Average                           |      | 33.46%                 | 13.84%         | 11.82%         | 15.96%        | 18.28%           | 3.15% |

The results of the identification of students' misconceptions on the material of the movement system and the circulatory system using MCSD-Test showed the percentage respectively 17.05% and 31.38%. Based on Table 2, it can be seen that students on the material of movement systems have the most misconceptions in the sub-concept of disturbance in the movement system by 27.53%, types of ossification by 25.41%, and frame function by 21.82%. Our findings on the sub-topic of movement system disorders, namely students assume that if the broken bone tip is very sharp it can penetrate the surrounding muscle and appear on the surface of the person's skin experiencing a closed fracture. The correct concept is that in patients with fractures the fracture ends penetrate the muscle until the skin surface appears, not a closed fracture [16]. Another finding is that students assume that intramembranous ossification begins with the formation of osteoblasts. The correct concept is initial intramembranous ossification by differentiation of mesenchyme cells into osteoblasts [17]. Students also thought that the red marrow in the bones contained epithelial cells which later produced blood cells.

In Table 3, it can be seen that students with the circulatory system material have the most misconceptions in the sub-concept of blood transfusion by 61.29%, disturbances in the circulatory system amounting to 46.11%, blood vessels by 49.92%. Our findings on the sub-topic of blood transfusions are students who think people with blood type A can donate blood to people with blood types A and O. The correct concept is that people with blood type A can donate blood to others who are
grouped so that clots don't occur [18]. Our other finding is that students experience misconceptions on the sub-topic of blood vessels. Students assume that the tunica externa is the vein that plays a role in maintaining blood flow in the direction of the heart. The correct concept is that veins have valves that keep blood flowing in one direction toward the heart [17].

Table 3. Results of the concept identification of the circulatory system

| Sub Topic                                               | Item                  | Understand The Concept | False Positive | False Negative | Misconception | Lack of knowledge | Guess |
|---------------------------------------------------------|-----------------------|------------------------|----------------|----------------|---------------|-------------------|-------|
| Blood components                                       | 16,17                 | 53.06%                 | 9.275          | 4.9%           | 16.29%        | 11.73%           | 4.71% |
| Blood clotting components                              | 18                    | 44.84%                 | 4.33%          | 23.47%         | 11.96%        | 12.26%           | 3.14% |
| The structure and function of space in the heart organ | 19,20,21              | 3.59%                  | 19.48%         | 19.28%         | 34.53%        | 21.67%           | 1.44% |
| Blood vessel                                           | 24,25                 | 4.86%                  | 6.42%          | 13.15%         | 49.92%        | 24.59%           | 1.05% |
| Blood transfusion                                      | 22                    | 5.53%                  | 10.31%         | 6.88%          | 61.29%        | 13.75%           | 2.24% |
| Rhesus factor                                           | 23                    | 1.45%                  | 4.48%          | 39.01%         | 30.34%        | 23.32%           | 1.35% |
| Short circulatory system                               | 26                    | 2.67%                  | 2.24%          | 45.29%         | 26.46%        | 21.97%           | 1.35% |
| Lymph system function                                  | 27                    | 11.66%                 | 18.98%         | 28.70%         | 12.41%        | 23.17%           | 5.08% |
| Circulatory system disorders                           | 28,29,30              | 7.92%                  | 31.09%         | 33.55%         | 46.11%        | 29.30%           | 2.02% |
| Average                                                 | 15.06%                | 11.85%                 | 23.80%         | 32.15%         | 20.20%        | 2.34%            |       |

This finding is relevant to previous studies [19,20] on the circulatory system material of students experiencing misconceptions on the sub-topic of blood vessels. The results of the research, students assumed that all veins carried dirty blood and all arteries carried clean blood. Some examples of misconceptions on the sub-topic disorders of the circulatory system, namely students think that hemophilia is caused by reduced production of blood cells. In addition, students think that sickle cell disease is due to a deficiency of leukocytes and that sufferers have abnormal hemoglobin. The correct concept regarding the sub-topic of disorders in the circulatory system, namely thalassemia is caused by the reduced synthesis of globin chains in hemoglobin, resulting in less hemoglobin in erythrocytes. Sickle cell disease is a genetic disease caused by a gene mutation. The erythrocytes of sickle cell patients contain abnormal hemoglobin [16].

In books that are used as learning resources for students, it turns out that wrong concepts are still found. This can be a factor in the misconception [21]. The teacher can actually prevent misconceptions from the student manual for example, before it is used, the teacher should identify the accuracy of the concepts in the biology textbook that students will use. The teacher can act as a filter for students. In addition, teachers can develop their own teaching materials by using reliable references that are guaranteed the accuracy of the concept. Other causes of misconceptions can come from various sources of daily life experiences [22] teachers, students [23], changes in scientific terminology [24]. Misconceptions that occur in high schools can be because students do not study the topic in depth in their biology learning process [25]. Misconceptions can hinder learning and prevent students from mastering more deeply about biology material. This is because misconceptions can hinder the process of receiving and integrating new knowledge into students' thinking. Therefore, it is necessary to identify misconceptions using diagnostic tests. This is in line with previous studies that highly recommended
diagnostic tests because of their accuracy in determining interconceptions. Identifying misconceptions is an important first step towards better science teaching and learning. Information about the causes of misconceptions is important for designing and creating learning strategies that aim to prevent or correct misconceptions.

4. Conclusion
The results of the identification of students' misconceptions on the material of the movement system and the circulatory system MCSD-Test showed the percentage of 17.05% and 31.38%, respectively. Textbooks that contain wrong concepts can cause students to misconceptions. Further research can be carried out to identify misconceptions in other biological materials and develop teaching materials which contain the correct concepts.

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