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Students' Visual Representation of Lights and Visions

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Abstract: Visual representations are used by scientists to communicate scientific conceptions and are used by teachers to teach science in the classroom. The 2013 Curriculum textbook reduces this visual representation. Meanwhile, visual representations will help students develop a comprehensive understanding of the concept. This case study research aims to reveal cases of misconceptions in the visual representation of students at an X elementary school. We used observations of fifty-nine fourth-grade elementary school students to find students with different cases of misconceptions. Eleven students were further identified using interviews and drawing tests. We analysed the data qualitatively based on the collection of these two types of data. We found misconceptions in the representation of luminous objects and how students draw visions of luminous objects and non-luminous objects. Research results showed that we found cases of misconceptions similar to the findings from previous studies. While light and vision are prerequisite concepts, a student's conception of vision is affected when he has a misconception about light. Content can be developed by paying attention to the various modes of representation, conceptual change, and learning progression in the future. The pattern of learning progression can be studied in more detail using the microgenetic method.

Keywords: Elementary school students; Lights; Vision; Visual representations

Introduction

Science is always represented by scientists so that students can easily learn about natural phenomena. Students use these scientific representations in the classroom to learn and understand the concepts. It needs to be increased in science learning (Namdar et al., 2016). If this base is increased, it will be able to increase students' deeper understanding of concepts about science (Wu et al., 2013). Teachers must communicate well with students to support good participation (Yuliana et al., 2021) so students know the existing concepts in science learning, exceptionally light and visions (Hamdiyati et al., 2022).

Various studies conclude the importance of representational competence for science learning (Chang, 2018), and the study of student representation plays a decisive central role in science teaching (Ravanis et al., 2010). At the elementary school level, students already have a rich knowledge base and sophisticated cognition (Elmesky, 2013). It means that students at this age can learn abstract and deep content such as those related to representation.

Students with a representation that contradicts the scientific explanation of a scientific concept are referred to in the literature as misconceptions (Ravanis et al., 2010). Many students have various knowledge of scientific conceptions when they come to school. This misconception hinders them from getting a scientific conception (Hunaidah et al., 2022; Sopandi et al., 2017). Scientific knowledge is mainly constructed on a student's own. Sometimes, misconceptions occur when students' construction process in observing natural phenomena is not facilitated through learning. Some causes of this misconception were identified in a study, such as student preconceptions, erroneous reasoning, humanistic thinking, and associative thinking (Adi et al., 2019). Meanwhile, a concept in science becomes the

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basis/prerequisite for the next concept, so that misconceptions can become a big obstacle in learning science. Misconceptions in the initial concept may continue to the next concept (Desstya et al., 2019; Kartimi et al., 2021; Masfuah et al., 2021). Diagnosing elementary school students' misconceptions is urgent to avoid further problems (Desstya, Prasetyo, & Suyanta, 2019).

The case found in the 2013 Curriculum Student Book Class IV Elementary School Theme 5 Revision 2017 Sub-theme 1 Learning 3 on page 26 verbally represents the vision process. However, the textbook needs to pay more attention to the importance of visual representation of this concept. Meanwhile, textbooks can cause students misconceptions (Suparno, 2013). It may underlie that misconceptions about light and vision are often found at the elementary school level (Haidar et al., 2020; Ravanis, 2019; Ravanis et al., 2009). Textbooks can include various representations to develop students' knowledge (Bergqvist et al., 2017). A research finding states that researchers in Asia are less focused on researching science textbooks, especially at the elementary school level (Vojíř et al., 2019). According to the criteria, a content analysis of textbooks should be carried out to understand the drawbacks and recommend textbook writers' improvement. The use of verbal and visual representations in learning concepts must be presented.

Students will be interested in learning science if the content is presented in verbal form and other forms of representation, such as visuals (Chusni, 2022). Students' ability to understand a concept through visual media is called visual representation. However, research shows they do not understand the content presented through drawing. This is because the content is abstract, so phenomena modeled through drawing remain difficult to facilitate (Asriadi et al., 2022). Meanwhile, students who take science lessons must be able to change the verbal concepts they learn into other forms, such as visuals, and vice versa (Syahmel et al., 2019). On the other hand, visual representations are used in science classrooms for various purposes for teachers and students. In general, the reasons for drawing in science have benefits for (a) enhancing engagement, (b) learning to represent in science, (c) reason in science, (d) as a learning strategy, and (e) communicating (Ainsworth et al., 2011). It was also conveyed that visual representation is essential to communicate ideas in science class (Cook, 2006). Drawing media that can visualize students' imagination of a concept will increase students' understanding when combined with an appropriate instruction (Adnyana et al., 2019).

Learning is always progressing. Assessment for learning can be used to develop better learning. Teachers can use diagnostic tests to identify their students' misconceptions (Dewi et al., 2022; Rokhim et al., 2023). They must be able to identify students who have misconceptions to provide solutions (Margunayasa et al., 2021). In addition, drawing proved to be an excellent tool for detecting preconceptions and evaluating students' learning progression (Reinoso et al., 2020). Findings from research trends also indicate the use of drawing assessment to assess students' conceptions of content in science learning (Chang et al., 2020).

Several studies have discussed the misconceptions about light and vision, especially at the elementary school level. However, there is still a small amount of research that discusses the visual representation of elementary school students. In addition, we want to identify various types of visual representation misconceptions in order to plan appropriate learning designs. Physics has scientific concepts that are more abstract and difficult for children to understand, exceptionally light and vision. Based on this, research is needed to find out 'the visual representation of students' so that they can be followed up if any misconceptions are found. This paper aims to answer the question, "What is the visual representation profile of elementary school students about light and vision?"

Method

This paper discusses a case study from a preliminary study on the problem of elementary school students' representation of light and vision. Our consideration in determining purposive sampling is finding a student with a misconception indication. We observed 59 4-th grade elementary school students in the suburbs while learning science to find students who indicated misconceptions in their visual representations. Twelve students were then identified using interviews and drawing tests. The instrument used to test the concept of Visual Representation about Light Sources, Visual Representation about Non-Luminous Objects, Visual Representation about Vision on Light Sources, and Visual Representation about Vision on Non-Luminous Object.

Our student drawings are analyzed based on the level of visual representation that we have developed. In the context of this article, we only analyze cases of Misconceptions. Students who visualize their concepts with a drawing contrary to scientific conceptions and are convinced about their drawings are included in this case. The initials are used to reveal their identity in secret.

We used qualitative data analysis from Miles & Huberman through data reduction, data display, and conclusion drawing (Sugiyono, 2018). If we found a similar case of misconception, e.g., Student A believed that the Moon was a light source object like Student B, we reduced the data for this case. Then, we will display their drawing cases for discussion with any relevant scientific evidence. Triangulation by collecting data with different data collection techniques (observation and interviews), confirming the representation of students in different times, situations, and students.

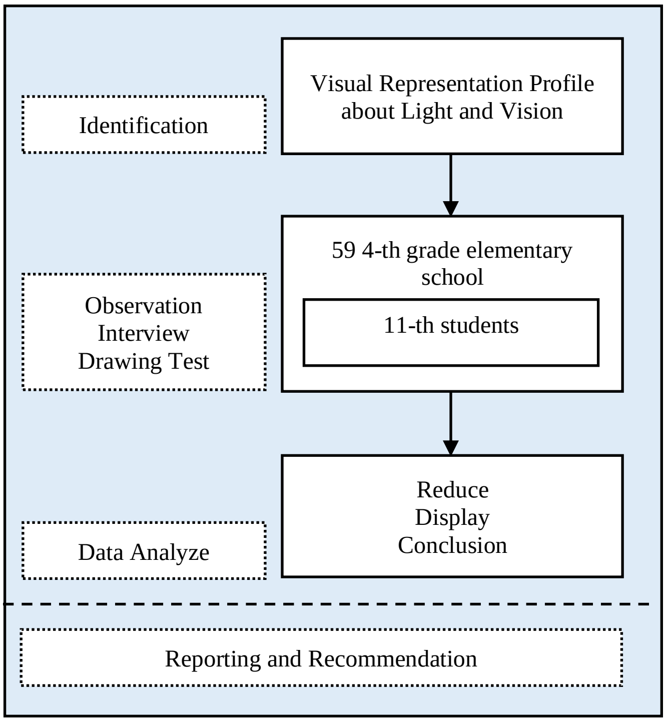

Figure 1. Case study flowcharts

Result and Discussion

Science learning believes that students construct their knowledge when they meet natural phenomena. However, knowledge construction that is not facilitated can lead to misconceptions. Visual representation as a variable in this study was examined through a drawing test to identify the misconception profile. The description of the misconception profile is 'Students visualize concepts with drawings as opposed to scientific conceptions.

Visual Representation about Light

In the case of Light Sources, misconceptions were found in some students. For example, Yog, Mau, Tha, Dha, Zaf, and Aul, believe that the Moon is included in the light source. A unique case is found in Jih, who believes that mirrors are light sources because they look shiny to her. Tha also mentions that mirrors are light sources because they can reflect. In addition, Dim also believes that a white book is a light source. Dha drew the cloud in his list of light sources. Finally, Aul and Jih could name Stars in the light source list but visualize misconception shapes.

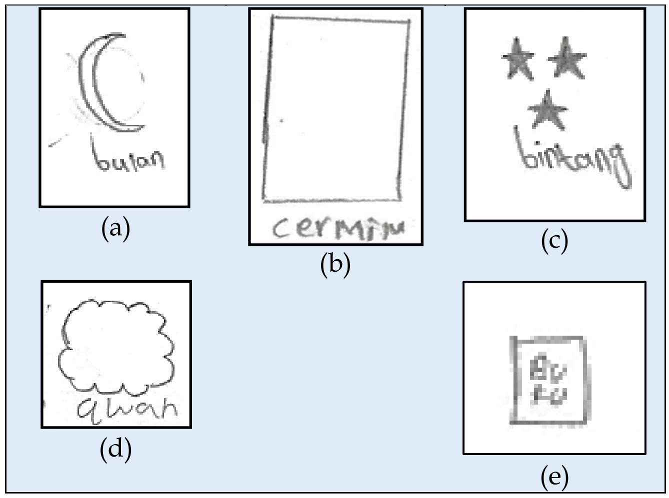

Figure 2. (a) Moon; (b) Mirror; (c) Star; (d) Cloud; and (e) White book

In the case of Non-Luminous Objects, a misconception was only found in one student. Dha puts the TV in the non-luminous object list. His consistency also supports this belief through interviews with him.

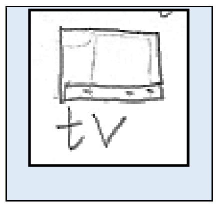

Figure 3. TV

Cases in this study were also found in previous studies. In the first case, elementary school students believed the Moon was a light source (Allen, 2014). The same finding is related to the Moon as a light source as it illuminates the Earth at night (Nurfiyani et al., 2020; Uzun et al., 2013). Meanwhile, the Moon is a celestial body with a surface that can reflect sunlight. Students thought this reflection was light coming from the Moon itself. Another case became a new finding.

Visual Representation about Vision

In the case of Vision on light sources, some students found misconceptions. Ilh, Ani, Zaf, Dik, and Jih have a misconception that the human eye can see light sources automatically because the eye has a visual function. Some of them mention that light is coming from the eye towards the light source object. The following case concerns a misconception in the eye that can see the light that shines on a flashlight. Mau explains that light is needed from another light source object when we need to see a light source object. She added that the eye still has a visual function. Tha is still visualizing the Moon to the vision process on a light source object at once with the direction of the unclear light beam (lines without arrows). Finally, Dim considers that the lamp's light has a role in lighting while the eyes remain the primary function in seeing books.

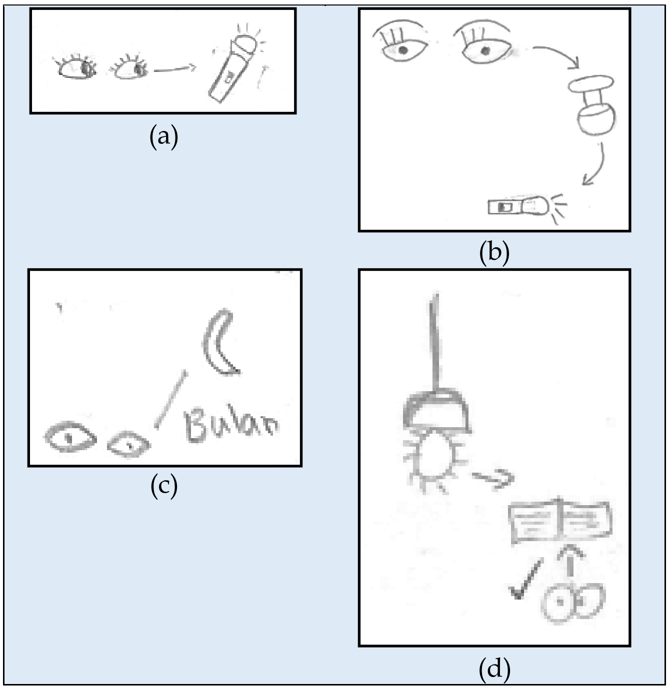

Figure 4. (a) The eye looks automatically at the light source object; (b) The eye sees a light source because of another light source; (c) Unclear visual processes and erroneous examples, and (d) The light source hits the object and the eye automatically sees it

In the case of Vision on a non-luminous object, some students found misconceptions. Ilh, Zaf, and Jih consistently visualize vision on non-luminous objects with their eyes seeing them automatically without being influenced by other factors. Tha still represents unclear visual processes but with appropriate examples. Dim's misconception also has consistency with the need for light source objects to illuminate non-luminous objects. Meanwhile, the eye still has the main function in vision.

Cases in this study were also found in previous studies. When asked to draw arrows of relationships between components in the light-object-eye vision process, some students thought the light was coming 'from the eye to the object' or 'from the eye to the light source.' Students assume that a light source is sufficient in the vision process, or vision is sufficient only with the eye, and light from the light source propagates to the eye and then propagates to an object so that the object can be seen (Uzun, Alev, & Karal, 2013). They added that elementary school children with upper grades are vulnerable to Secondary Reception in which light travels from the first light source to the object, then to the eye, Illumination of the Object in which the light source illuminates the eye and the object simultaneously, Sea of Light where the source of light generally illuminates the space, and Cooperative Emission in which both the eye and the light source emit light towards the object (Kokologiannaki et al., 2012). Other cases are new findings.

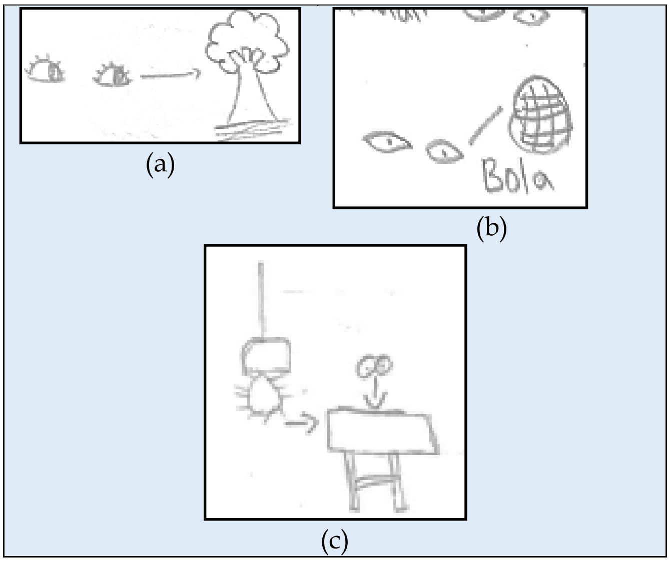

Figure 5. (a) The eye automatically sees a non-luminous object; (b) unclear visual processing; and (c) Light from a light source object hits a non-luminous object but the eye automatically sees it

In fact, the visual representation of vision that we found is not much different from previous research findings. For example, Jack's case in Figure 6 also describes vision as the process of light shining on objects and, at the same time, the eyes. Only a third of students have more scientific representation. However, after going through visual representation-based learning, they showed significant progress (Xu et al., 2021).

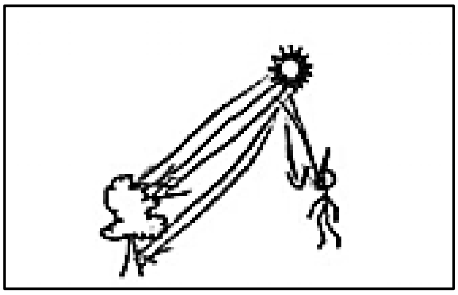

Figure 6. Jack's case from Xu, Prain, & Speldewinde (2021)

The results showed that we found cases of misconceptions that did not progress significantly with the findings of previous studies. As if science learning does not progress from time to time. As is known, students' pre-conceptions hugely affect their scientific representation (Chang, 2018; Cook, 2006; López et al., 2017). Students use their life experiences and prior knowledge to understand phenomena, and this is prone to misconceptions that hinder them from understanding scientific concepts (Hunaidah et al., 2022; Juita et al., 2023). Therefore, the misconceptions on prerequisites concepts can lead to further misconceptions. The concepts of light and vision are prerequisites. When misconceptions occur in the light, students are also affected by their conception of vision. For example, students give an example of the Moon as a light source. When asked to draw the vision process on a light source object, students still drew the Moon.

Students will easily construct their knowledge when they have scientific conceptions, while misconceptions create learning obstacles. Teachers should be experienced in identifying their students' misconceptions (Cahyanto et al., 2019). Drawing can be used as a diagnostic test alone or with other diagnostic tools (Dirman et al., 2022). Different levels of visual representation can be used as case examples by teachers to guide students to produce more scientific visualizations (Park et al., 2020). For instance, one of science learning designed to emphasize hands-on experience for students will help them gain a deeper and more scientific understanding will create a long-term memory of understanding concepts (Hardiansyah, Misbahudholam, & Hidayatillah, 2022; Suryana et al., 2021; Syahmel & Jumadi, 2019).

Several notes are recommended for sophisticated learning progression. First, visual representation with pictorial mode needs to be used more in the teaching process, and this can be visualized in teaching materials and textbooks. It is intended that students are more often in touch with nature when learning science (Kubiatko et al., 2009). Second, teachers need appropriate teaching strategies to facilitate their conceptual change by constructing schemas of thinking about light and vision (Ravanis et al., 2013). Third, the learning design must be developed by considering students' differences. It is intended that visual representations are effective when taught to them (Cook, 2006). Fourth, the teacher can use visual representations with different levels of drawing to guide students in producing scientific explanations through drawing. The rationale is that each student develops in a different pattern (Park et al., 2020). Fifth, an effective reading process requires reading skills, pre-concepts, attention, and external support. Teachers must pay attention to these things to take advantage of the potential possessed by students regarding visual representation (López et al., 2017).

The development of visual representation-based teaching materials can be directed at conceptual change and pay attention to learning progression. Representations between concepts will also be able to develop through representation-based learning with multiple modes (Suminar et al., 2017). The pattern of learning development can be studied using a more detailed method. It is recommended to use the microgenetic method to study the pattern of student learning development in detail (Brock et al., 2017). Therefore, the process of students learning science develops randomly, progresses, and can even regress (Hamid et al., 2017). Teachers can use the information provided through learning progression analysis to understand individual or general student development when facilitating classroom learning (Anggoro et al., 2022).

Conclusion

The research results concluded that the students' misconception cases included Visual Representation about Light, Vision on Light Sources, and Vision on Non-Luminous Objects. For example, students give the example of the Moon as a luminous object and represent vision by drawing eyes and seeing light from the Moon. We found cases of misconceptions that did not progress significantly with the findings of previous studies. Other cases are new findings. The concepts of light and vision are prerequisites. When misconceptions occur in the light, students are also affected by their conception of vision. Several notes are recommended for sophisticated learning progression. The development of visual representation-based teaching materials can be directed at conceptual change and pay attention to learning progression. Visual representation-based teaching materials can be a scaffold for students to achieve a more scientific visual representation. Future teaching materials can be developed by paying attention to visual representations instead of just verbal ones, thus leading to multiple representations. The pattern of learning progression can be studied using a more detailed method; the microgenetic method.

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Author Contributions

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Conflicts of Interest

The authors declare no conflict of interest.

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