

ARTICLE

# Analysis of senior school students' preconceptions regarding the concept of climate change in terms of visual representation explorations

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## Abstract

Preconceptions are essential initial understandings that students possess, as they serve as the foundation for better learning. Regarding the concept of climate change, many students still harbor misconceptions. One way to identify students' preconceptions is through the use of visual representations. The use of visual representations can unveil students' preconceptions about abstract and complex concepts. This study aims to observe and analyze the extent of high school students' understanding of climate change. It employs qualitative descriptive research, with a population and sample comprising 63 tenth-grade students majoring in natural sciences at a high school in Indonesia. Data collection techniques involve observation and interviews, with semi-structured interviews utilized in this study. The results reveal that students have varied understandings of the climate change concept, with many still holding misconceptions. There are three categories of climate change concepts: 1) accurate climate change concepts, accounting for 37% (23 students); 2) climate change concepts based on objects, as observed from the overall visualized images created by the respondents; and 3) incorrect climate change concepts, constituting 63% (40 students). From these categories, based on empirical evidence regarding students' preconceptions of climate change, it falls into the macroscopic level.

**Keywords:** Visual representation, climate change, senior high school

## 1. Introduction

Climate change has become a hotly discussed topic and an increasing global concern. In 2020 alone, almost all regions experienced more heatwaves and increasingly scorching weather, primarily due to the fact that the impacts of climate change are already evident in various aspects of human life (Harmuningsih et al., 2017). One of the major causes of this climate change is global warming, with the rising levels of greenhouse gases, especially CO<sub>2</sub>, in the atmosphere. This has resulted in climate change that negatively affects human activities on Earth. Climate change could become frightening if it continues unabated and is not addressed further, and addressing it requires the involvement of all elements of global society, including Indonesia.

One strategy that can be employed is through education, as it is an effective means to understand and teach risk management for the impacts of climate change. Building students' awareness of environmental issues caused by climate change is undoubtedly challenging. Environmental education in Indonesia is still conducted separately, and there has been no curriculum update to enhance environmental education. Previous research indicates that students' understanding of climate change concepts is still minimal (Rosidin Suyatna, 2017; Nugroho, 2020).

One of the reasons for this low understanding is the learning process in schools, where the topic is not directly taught in the classroom and is not integrated into daily life. Additionally, many students have misconceptions about climate change, perceiving the physics-related aspects of climate change as difficult to comprehend. They view climate change material as abstract, complex, and too general, leading to misunderstandings of the concepts.

Therefore, understanding students' initial comprehension of a concept is crucial. Before progressing to new and continuous concepts, students' initial understanding serves as a foundation for their learning process. Furthermore, the initial understanding of the concept of climate change is essential to provide students with a deeper understanding of the ongoing climate change. Previous research analyzing the basic skills students must possess in the 2013 curriculum for science subjects indicates that the concept of climate change is not included in the basic competencies. This is one of the reasons why students' understanding of the concept of climate change remains low (Nabila Shavina, 2022).

It is known that students in Indonesia still have a low awareness of climate change and consider it a non-serious issue (Sulistiyawati et al., 2018). Hence, there is a scarcity of research exploring students' preconceptions about the concept of climate change, even though uncovering preconceptions is crucial to understanding students' ideas and thoughts about a new subject.

Preconceptions are students' initial understanding before learning about a particular topic. Each student has different prior knowledge (preconceptions), which can come from experiences, knowledge, and information acquired outside of school. Regarding climate change, students already have initial preconceptions that can serve as a starting point for knowledge about the subject. Therefore, efforts are needed to determine students' preconceptions before starting physics education, and one way to do this is through the use of visual representations. Visual representations can unearth students' understanding of specific concepts, serving as a tool to investigate students' preconceptions about a particular physics concept. The results of this analysis can guide teachers in designing better lessons with the use of visual representations.

There have been numerous studies related to visual representation, with one example being the research conducted, which discussed visual representation in physics education in high schools. This research observed that the improper use of visual representation can lead to misunderstandings and difficulties in comprehending the material (Widianingtiyas 2015).

This study aims to examine and analyze the extent of high school students' initial understanding of the current concept of climate change. Understanding students' preconceptions about the concept of climate change is crucial not only for their future but also in line with the current national curriculum requirements. Therefore, the researcher is interested in conducting a study titled "Analysis of High School Students' Preconceptions about the Concept of Climate Change from the Perspective of Visual Representation Exploration".

## 2. Literature Framework

### 2.1 Preconceptions

Preconceptions are the initial ideas already present in an individual's mind regarding a concept before learning about a new concept. Preconceptions refer to the initial understanding or intuitive concepts held by an individual before formally studying a concept. This aligns with the philosophy of constructivist education, which asserts that students' initial preconceptions are modified through

social and physical interactions in the classroom during the learning process. Preconceptions can form misunderstandings or difficulties in comprehending newly learned concepts. Essentially, each student has different conceptions influenced by their personal experiences in daily life, resulting in varying preconceptions about a material concept. This depends on daily experiences, tentative concepts, and previous learning outcomes.

According to Redish and Hammer (2009), preconceptions are mental models that individuals have about a natural phenomenon based on daily experiences, tentative concepts, and previous learning outcomes. Additionally, in Nafisah Amatullah's research (2019), preconceptions are described as the initial understanding or conception that students possess before formally learning a concept. For instance, at the beginning of a lesson before introducing new material such as Newton's Laws, a teacher may inquire about what students already know regarding Newton's Laws. Naturally, each student will have different responses due to their varied experiences, such as moving objects, stationary objects, objects being pulled, and so on. Consequently, students already have initial conceptions that may not necessarily align with the conceptions of scientists. This should be a concern for teachers to address, ensuring the improvement of students' understanding in the learning process.

## 2.2 Student conceptions to climate changes

Climate change refers to long-term changes in the global atmospheric conditions that occur over several decades or more. This is in line with the view of Prasad, as cited from the Intergovernmental Panel on Climate Change (IPCC), stating that climate change is a statistical change in climate identifiable over a sufficiently long period, typically estimated within a decade or more (Prasad and Mkumbachi 2021). According to the National Aeronautics and Space Administration (NASA, 2021), climate change involves changes in global and regional climate characteristics that are estimated to result from human activities, such as the use of fossil fuels, deforestation, and air pollution. Climate change is often equated with changes in weather and seasons. However, weather changes refer to short-term atmospheric conditions, usually over a day or a week in a specific region. According to Gunawan Tjahjono (2010), weather changes are variations or short-term alterations in atmospheric conditions that can occur within a short period, such as a few hours or days.

According to Mfouapon et al. (2019), formal education does not always influence students' understanding of climate change. Some students have varied understanding, and many are unaware of climate change and use renewable energy. Several researchers have conducted studies to identify students' conceptions. For example, a study by Setianta and Liliawati (2019) identified misconceptions among high school students regarding global warming. The study found that out of 271 students tested on 20 questions and 40 concepts, 26 concepts were significantly identified as misconceptions out of the 40 tested concepts. The percentage for misconceptions reached the highest value of 61% with a high category. The total average was 19.14% with a low category.

Wandersee, Mintzes, and Novak (1994) in their article on Research on Alternative Conceptions in Science explained that alternative concepts occur in the field of physics. Out of 700 studies on alternative concepts in physics, 300 investigated misconceptions in mechanics; 159 in electricity; 70 in heat, optics, and properties of matter; 35 in earth and space; and 10 in modern physics. From these research findings, it is clear that studies on climate change are still minimal, despite it being a crucial and important topic. In this study, students' conceptions often experience misconceptions about concepts that contradict what scientists believe, leading to students being considered to have misconceptions.

In a previous study, researchers examining students' descriptions of global warming, it was found that 75.86% of students had misconceptions about the subject (Mardatila, Novia, and Sinaga 2019). For example, some students believed that global warming is caused by the thinning of the ozone layer, some thought it causes skin cancer, and many students believed that acid rain is a result of global warming, among other misconceptions. In the discussion of climate change, students believed

that it is a change in weather due to seasonal changes, resulting in different air temperatures. The correct concept of climate change, however, is the phenomenon of an increase in the average global atmospheric temperature caused by human activities, especially the use of fossil fuels and deforestation, resulting in greenhouse gas emissions and an increase in Earth's temperature. As a result, many students have misconceptions about the concept of climate change.

### 2.3 Visual representation

According to Elkins 2002, visual representation encompasses everything presented in the form of images or visualizations in any media, interpretable visually by an observer. Representation is a method used to express phenomena, objects, concepts, ideas, processes, or systems. These representations are considered capable of influencing an individual's knowledge and information to interpret and reason about the provided information. Scientists often use representations to explain concepts, ideas, laws, as well as systems and processes. Eilam and Gilbert 2014 states that visual representation is a mechanism of recognition and perception that can transform visual information into actions and understanding. Representations serve as intermediaries that support the human thinking process, defining representation as a process involving effective communicative understanding, organization of ideas, and the development of concepts and models to explain acquired knowledge (Albers 2013).

In the field of science, explaining ideas and concepts is more engaging when using verbal explanations, images, diagrams, graphs, maps, or other visual statements, making it easier for people to understand. Scientists also modify and combine existing representations to provide explanations for events or phenomena. In textbooks, visual representation can be presented as images, diagrams, graphs, maps, and more. This is done because it directly influences students, especially in the form of perceptions related to concepts and tools, making visual learning play a crucial role in the learning process (Asenova<sup>1</sup> and Reiss 2011). From the literature review, it can be concluded that there are at least two objectives for using visual representation in learning: firstly, as a pedagogical tool, and secondly, as an assessment tool. Evidence from another literature review (Mayer and Pilegard 2005) that suggests that visual representation can help students store and remember information better. At least three stages of the visualization process in learning can be outlined from this theory: (1) understanding visual information, (2) processing information into cognitive structures, and (3) externalizing information as a visual model, such as visual representation. This proves that visual representation plays a crucial role in teaching and learning, as it helps students understand and remember information better.

One important factor in using visual representation as an assessment tool, especially for investigating preconceptions, is that it allows students to relate experiences to specific concepts. Additionally, it can visualize abstract concepts, representing complex and unobservable phenomena. This visualization can help students clarify difficult information, enabling them to devise better learning strategies (Mayer, R. E., 2001). Therefore, when students create visual representations of their learning outcomes, they are actually helping themselves to improve and strengthen their learning. Hence, visual representation can act as a tool in teaching and learning for the students themselves (Weurlander et al. 2012).

### 2.4 Images as evaluation tools

One efficient instrument for assessing learning outcomes is the use of images. Concepts can be comprehended, and ideas can be conveyed through images, diagrams, or verbal communication. Images serve as an evaluation tool capable of expressing an individual's thoughts, explaining functions, and providing insight into specific situations. Physics concepts constitute a subject that not only involves memorizing formulas but also deals with abstract concepts, demanding a deeper understanding for effective learning. Images, as a medium, can accurately and comprehensively combine

facts and ideas through the combination of verbal expressions and visual representations (Maryani, Martha, and Artawan, 2013; Yuswanti, 2014). Furthermore, images are considered tools for solving complex and abstract physics problems. Research conducted by Sari *et al.* (2017) focused on creating physics learning modules based on real-life events in high schools. However, the use of images as an assessment tool in physics education is still underutilized due to a lack of encouragement from teachers for students to represent physics concepts visually.

Images are an effective means of developing a student's thoughts and ideas to explain complex concepts that are challenging to articulate in words. Therefore, using images as an assessment tool can be an excellent means of evaluating a given concept. Through the use of visual representations, a teacher can gauge a student's initial understanding of a new concept. Evaluation tools in education are crucial for educators to understand each student's abilities, making image-based assessment an objective method (Arum, Abdurrahman, *et al.* 2014).

In the analytical framework used in this research, the focus is on the use of visual representation as an assessment tool because it reveals three levels of understanding based on the visual representation scale produced. These visual representations include: (1) macroscopic (can represent everyday experiences, e.g., human deforestation activities, air pollution resulting from deforestation, atmospheric CO<sub>2</sub> concentration), and (2) mesoscopic (representations in a narrower context, such as a map of global sea surface temperature anomalies). Microscopic (visual representations analyzing isotopic spectra in specific environmental contexts, such as water, soil, and air). This is crucial for enhancing understanding from concrete experiences to more complex concepts. Additionally, it is relevant, especially for highlighting content (Chevalier, Vuillemot, and Gali 2013; Vosniadou 1994), to determine specific focuses during the teaching and learning process. In this study, visual representation is employed as a diagnostic tool to identify students' preconceptions about the concept of climate change. Specifically, it aims to: (1) identify whether visual representation is an effective tool for identifying students' preconceptions about the concept of climate change; (2) develop a methodology for using visual representation to identify students' preconceptions about the concept of climate change. This is considered helpful for teachers to understand and characterize students' preconceptions, enabling them to develop specific strategies to address conceptual difficulties and guide students toward more advanced and complex concepts during the learning process (Amaliah and Purwaningsih 2021; Ariyanto, Priyayi, and Dewi 2018).

### 3. Research Method

#### 3.1 Research design

The research design used in this study is qualitative descriptive. Qualitative research design aims to understand and explain social phenomena and individual experiences through the analysis of data in the form of words, texts, images, and cultural objects. Several important reasons for using this research design include: (a) focusing on discovering the nature of specific events or phenomena under investigation; (b) the research is conducted in a highly factual environment to avoid the Hawthorne effect, where research participants behave differently when they know they are being observed; (c) intentional sampling is employed with the goal of obtaining cases that are rich in information; (d) data analysis does not need to adhere to pre-existing rules; (e) data presentation involves direct description and summarization of the obtained information.

From the explanation provided, it aligns with the literature found in previous research that focuses on: (1) analyzing students' preconceptions of the concept of climate change through the exploration of visual representations; (2) analyzing errors in solving problems related to the visual representation of geometric optics concepts; (3) combining various procedures outlined in existing literature for data analysis; (4) implementing visual representation in learning to understand concepts. Therefore, this research is relevant in using qualitative descriptive methods to analyze a phenomenon and to analyze students' preconceptions of a specific concept.

### 3.2 Participants

Research participants are individuals, events, or objects studied to gather relevant data on the research topic. In this study, the population consists of tenth-grade science students aged 15–16, enrolled in one of the high schools in Garut Regency for the academic year 2022/2023. The total number of participants is 63 tenth-grade students. The sampling technique employed in this research is purposive sampling, as qualitative research is conducted based on the research objectives and predefined criteria.

### 3.3 Instruments

The instruments used in this study consist of observation sheets and interviews. The first instrument is an observation guide in the form of a sheet of paper as shown in Figure 3.1, and for additional equipment, respondents are encouraged to prepare writing tools to draw an object focused on a specific problem. The second instrument is an interview guide with in-depth interviews. This interview guide consists of general questions that demand long responses. In the interview process, the researcher uses a recording tool, such as a smartphone recorder, to capture the interview results.

Out of a total of 63 students in two classes, 21 students were called for individual interviews. Ten students were selected from each class for the interviews, which lasted for 5–10 minutes. The interviews took place in the classroom during the learning process. During the interview process, the researcher tried to remain as neutral as possible by asking each student to explain their ideas and thoughts in the visual representation they created. Two questions were posed during the interview: "What is the meaning of the picture?" and "From the picture you wrote, can this happen or does it often happen in everyday life? Please explain."

### 3.4 Data analysis

The thematic analysis method is the analytical approach employed in this research after all the data has been collected. Thematic analysis involves the process of identifying and categorizing preconceptions based on categories generated from codes, and the reliability of interpretation is crucial. In this study, since the data consists of visual representations or images, the analysis of visual data follows a four-step approach developed (Duncan 2013). The procedural steps are as follows: (a) Annotation of visual representations is reviewed, and notations are made by labeling objects/contexts depicted in the drawings, (b) Isolation of where visual representations are organized according to interpreted meaning, detailed descriptions of each individual visual representation are created, (c) Organization of visual representations into several categories, and (d) Synthesis of visual representations according to different categories.

For the analysis of interview data, the thematic analysis (TA) method, also known as interpretative thematic analysis, is conducted. TA is defined as a method to identify, analyze, and report themes or patterns present in research data. The process involves several main steps. First, the researcher reads and listens to the entire content or transcript of the interview repeatedly and carefully to extract meaning from the transcript Liamputtong 2009. The researcher may highlight words that align with the relevant meaning from the interviewee to facilitate understanding of the actual meaning. In the second step, the researcher assigns codes to identify data that is potentially relevant to the research questions and provides a brief summary of some of the data. In the third step, theme determination, themes are built based on the previously assigned codes related to the research phenomenon, forming several themes. The researcher then explores relationships among the existing themes to create a comprehensive response to the data from the research. If a code or theme does not align with the overall research, it may be replaced with a new theme.

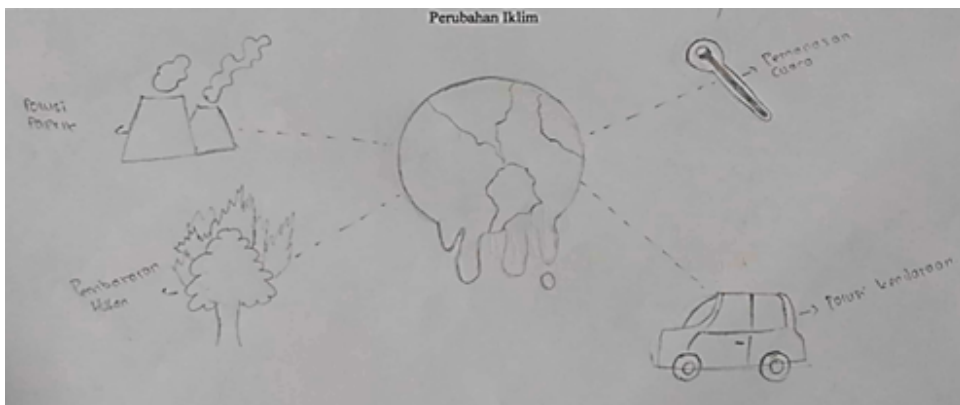
## 4. Result of the research

The data described were obtained from the research results using observation sheets and interviews filled out by the participants. In the observation sheets, participants were directed to draw according

to the preconceptions of students' visual representations of the concept of climate change. The research results were then processed, and several data points were obtained, including: 1) correct concepts of climate change, 2) concepts of climate change based on objects, and 3) incorrect concepts of climate change.

#### 4.1 *Appropriate concepts of climate change*

From the results of the data analysis, after categorizing them into three parts, the first is the concept of climate change that is correct. From the observations and interviews conducted on 63 students, it was found that 23 students, or 36.51% of the students, represented their drawings of the concept of climate change correctly. In this category, it is reviewed in terms of the definition of climate change itself, where climate change is a phenomenon of the increasing average temperature of the global atmosphere caused by human activities, especially the use of fossil fuels and deforestation, resulting in the emission of greenhouse gases. As a result, it affects extreme weather changes, the rise in sea levels, and various other environmental issues. Here are some sample data from students representing their initial understanding of the concept of climate change correctly.



**Figure 1.** An image example of appropriate concepts of climate change

Interviewer: According to you, what is the meaning of the picture? Please explain.

Student: Weather warming affects climate change on Earth, and factory pollution also, um, what's the term, changes Earth's climate by polluting the air. Deforestation is also the same as air pollution.

Interviewer: From the picture you wrote, can this happen or does it often happen in everyday life? Please explain.

Student: Yes, for vehicle pollution, but not really here.

The visual conception of climate change itself involves the warming of the weather that affects climate change. This is closely related to the concept of climate change in physics, which explains that human activities such as deforestation and vehicle pollution can increase the concentration of greenhouse gases such as carbon dioxide in the atmosphere. In the visual conception drawn, the respondent shows that climate change can occur due to deforestation, causing forests to become barren and reducing oxygen levels on Earth. Additionally, vehicle pollution and factory pollution contribute to climate change. If these activities continue, it will result in a warmer Earth temperature because the atmospheric layer, which should be Earth's protection, gradually thins due to human activities that neglect the environment.

From the interview results regarding the visual meaning with the statement "Weather warming affects climate change on Earth, and factory pollution also changes Earth's climate by polluting the air, and deforestation also causes air pollution," the statement is considered entirely true. In reality, weather warming can occur due to factory pollution and deforestation, as well as vehicle smoke pollution, resulting from continuous human activities that increase carbon dioxide levels. Consequently, the atmospheric layer thins, causing an increase in Earth's temperature and creating increasingly hotter weather.

#### **4.2 Climate change concepts based on object represented**

Furthermore, for the concept of climate change based on objects, it is reviewed from various objects that can be used as a foundation to understand the concept of climate change. Some objects that can serve as a foundation in the concept of climate change include Earth, atmosphere, ice layers, oceans, plants and animals, as well as humans, and several other objects. After analyzing the data, it was found that, of the total students (63 individuals), many depicted objects corresponding to the initial description, while some students portrayed other objects. From the analysis of the concept of climate change based on objects, it can be observed from Table 4.1 that, fundamentally, students' conceptions of climate change are well understood from the visual representations drawn by the students. The research results revealed objects that serve as foundations and significantly influence the process of climate change. Based on the data, some objects frequently depicted by respondents include plants with the highest percentage at 60.31%, clouds at 58.73%, rain at 39.68%, the sun at 52.38%, and Earth at 38.09%. From these percentages, it can be seen that many students assume that climate change will impact the ongoing processes of life on Earth. This is because the objects depicted by students are generally related to the ecosystem of living beings on Earth.

#### **4.3 Wrong concepts of climate change**

Basically, the concept of incorrect climate change is something that does not align with existing scientific data. After conducting observations, the researcher found that, based on the observations, 40 students out of 63 drew incorrect concepts of climate change, or approximately 63.49% of the total respondents. The basis for why the visual representations depicted are incorrect comes from the interview results with respondents. In the interviews, answers from several respondents did not align with theories relevant to climate change as acknowledged by scientists. The table below illustrates the misconceptions about climate change.

### **5. Discussion**

Based on the research results, it is found that there are three categories in students' understanding of preconceptions about climate change through visual representations. These include (1) Correct concepts of climate change, (2) Concepts of climate change based on objects, and (3) Incorrect concepts of climate change. From these three categories, each has a different percentage. The correct concept category is at 37%, and the incorrect concept category has a percentage of 63%. Meanwhile, for the category of concepts of climate change based on objects, it is reviewed from the overall images visualized by the respondents. From these percentages, it can be seen that many students still represent misconceptions about climate change, indicating that students' understanding of the concept of climate change is still relatively low. This aligns with previous research by Rosidin and Suyatna; Nugroho (2017; 2020), stating that students' understanding of the concept of climate change is still low because many students still consider climate change as a seasonal transition. It is also consistent with the research by Nur Utami et al. (2021), stating that the understanding of Newton's Third Law is still low. Most students are disturbed by the difference in mass between interacting objects, and they are also disturbed by the initial conditions of one stationary object. In



**Table 1.** Types of object in climate change representation

Type of objects	Frequency	Percentage
Earth	24	38.09
Cloud	2	3.17
Animals	5	7.93
Factory	10	15.87
Fog	10	15.87
Ice	4	6.34
Sea	4	6.34
Cloud	37	58.73
Plants	38	60.31
Thermometer	5	7.93
Atmosphere	7	11.11
Sun	33	52.38
Vehicle	2	3.17
Fire	3	4.76
Human	1	1.58
Gmail	1	1.58
Rain	25	39.68
Home	1	1.58
Lake	1	1.58
Drought	22	34.92
Moon	1	1.58
Total	63	100

**Table 2.** Wrong conceptions of climate change]

No	Wrong conceptions of climate change	Frequency	Percentage
1	Climate change from rainy to dry season	20	50
2	The sun shines on the earth, making it hot and causing dry plants in the dry season.	7	17.5
3	Natural changes, originally filled with trees, are now filled with construction, resulting in clean pollution becoming dirty.	2	5
4	Weather changes from clear to cloudy and rainy.	7	17.5
5	Climate change occurs, sometimes cold and sometimes hot.	2	5
6	Weather forecast for one week.	2	5
<b>Total</b>		<b>40</b>	<b>100</b>

the concept of climate change, students tend to not fully understand the meaning of climate change itself, so they assume that climate change is the same as a change in seasons.

In visual representations, students can draw related to the material to be conveyed through their thoughts on the concepts to be taught. From the research results, it is found that with visual representations of preconceptions about climate change, researchers can determine the extent of students' knowledge and understanding of the concept of climate change. Thus, the use of visual representation tests will be very beneficial in learning. The research results also show that students' initial understanding through visual representations is diverse and varied. This is in line with the research conducted (Gilbert 2005), which found that students often associate friction with human activities such as rolling and sliding objects on a flat surface and are contextual in nature. There are limited biases demonstrated by the non-representation of static friction and non-representation of friction at the mesoscopic and microscopic levels. Essentially, humans are equipped with the

understanding to develop what is in their minds, and this ability can foster a good conceptual understanding, which will later affect the process of students' understanding of a learning material. As stated by Kriss et al. in Abdurrahman (2008:373), humans can convey, receive, and interpret meanings through various forms of delivery and communication.

The results of the preconception test with visual representation skills show that most students still have problems in representing visual concepts of climate change through the pictures they create. Some problems faced by students include: (1) students still do not know what climate change is, (2) students themselves know the impacts of climate change, but for the concept of climate change itself, it is still unfamiliar, (3) many students assume that climate change is a change in weather from the dry season to the rainy season and vice versa. This can be proven by the results of students' drawings, which mostly depict climate change from the dry season to the rainy season. (4) Some students represent that climate change is a weather forecast for several days or weeks, as evidenced by the drawings depicting weather forecasts for one week.

From the observations conducted by the researcher through the analysis of students' preconceptions about climate change with visual representation exploration conducted on 63 students, it was found that 63% (40 individuals) represented drawings that were less accurate with the concept of climate change. Thus, many students still have misconceptions about climate change. Meanwhile, 23 students represented the concept of climate change correctly. From this, the researcher can see that the use of visual representation to understand students' initial concepts of climate change is essential. Therefore, based on the conducted research, it can be stated that the ability of visual representation to understand students' initial understanding of climate change has a significant impact.

## 6. Conclusion

Referring to the problem formulation and based on the analysis of observation and interview data processing, it can be concluded that students have different understandings of preconceptions about the concept of climate change. This can be seen from the visual representations depicted by students and from the interviews conducted with students. The results of the drawings and interviews with students show different images and opinions about climate change. From the analysis of visual representations of the concept of climate change, it can be differentiated into three categories: 1) Correct concepts of climate change; 2) Concepts of climate change based on objects; 3) Incorrect concepts of climate change. From these three categories, and based on empirical evidence regarding students' preconceptions about climate change, including at the macroscopic level, which means observations are based on students' daily experiences, at this level, students more often see and involve objects in large sizes that can be seen by humans.

Students experience misconceptions about the concept of climate change, which tends to be complex. The infrequent use of visual representations to understand students' understanding is one of the contributing factors. The difficulty for students to explain and describe the results of visual representations becomes a supporting factor for students to find it challenging to understand the concept of climate change. The rarity of teachers encouraging students to develop their visual representations based on their understanding of a concept is another factor that makes students less able to grasp the taught concept. Therefore, teachers can use visual representation as a tool to identify students' conceptual understanding in specific physics topics. Teachers can consider the use of visual representation as an evaluation tool for students.

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