Representation Elements of Spatial Thinking

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Abstract.This paper aims to add a reference in revealing spatial thinking. There several definitions of spatial thinking but it is not easy to defining it. We can start to discuss theconcept, its basic a forming representation. Initially, the five sense catch the natural phenomenon and forward it to memory for processing. Abstraction plays a role in processing information into a concept. There are two types of representation, namely internal representation and external representation. The internal representation is also known as mental representation; this representation is in the human mind. The external representation may include images, auditory and kinesthetic which can be used to describe, explain and communicate the structure, operation, thefunction of the object as well as relationships. There are two main elements, representations properties and object relationships. These elements play a role in forming a representation.

1. Introduction

There are several definitions of spatial thinking, but it is not easy to define it. This study refers to the definition of spatial thinking by NRC [1] states "Spatial thinking is a collection of cognitive skills. The skills consist of declarative and perceptual forms of knowledge and some cognitive operations that can be used to transform, combine, or otherwise, operate on this knowledge. The key to spatial thinking is a constructive amalgam of three elements: concepts of space, tools of representation, and processes of reasoning". In the following descriptions will explain further and discuss the concept and it is the basic a forming representation.

Initially, the human five senses will detect and capture the natural phenomenon then transfer it into memory for processing. There is a coding process that involves abstraction information to carry out the relevant information and ignore the irrelevant information. Abstraction plays a role in processing information into a concept. The information that relevant gathers up into a concept and create a structure that calls a schema concept. "A schema (plural: schemata) is a mental model, a way of understanding the world, a set of Assumptions or understandings about reality" [2]. The concept and structure are placed in the internal memory. This concept and structure will have to mean if it is expressed by the good symbol in the form of visual, auditory and kinesthetic. In the process of internal concept into theexternal concept in the form of visual, auditory and kinesthetic will continue as the external of representation. There are three steps of spatial thinking is digging the spatial structure, spatial transformation and draw conclusions. Representation plays an important role in exploring the spatial structure. There are two types of representation items, namely internal representation and external representation. The internal representation is also known as mental representation; this representation is in the human mind. The external representation may include images, auditory and kinesthetic which can be used to describe, explain and communicate the structure, operation, thefunction of the object as well as the relationships. There are two main elements, representations properties and object relationships. These elements play an important role in forming a representation.

1.1. The Characteristics of Representation Object

According to NRC:41 [1] stated that Representations is whether in the mind or external, map elements and their relations in the world to elements and their relations in the represented world. It means that the representation happened started from our five senses that able to detect a phenomenon. The elements and the relationship of the detections phenomenon will form into code in human mind.

There is anabstraction in the process of coding which is the elements, and therelevant relationship will be used, but the elements and theirrelevant relationship will be ignored. Abstraction of the elements and the association will be named, and eventually formed a concept. Someone said to master a concept that can describe the properties or characteristics and relationships of the objects.

This research begins from digging the characteristics of student's representation object in spatial thinking in the topic material of "Cube". How the process of students identifies then catches the cube model and mentioned the elements how the formula of the cube formed and described the abstraction process up to forming in the cube concept in their mind. Further revealing about how students express a cube that exists in the minds of students into the external representation whether in the form of drawings, models or using words. Data obtained in the form of a direct description of the interview.

1.2. Relationships between Object

Relationships between objects need to be considered to expand the concept. There are two relationships between objects are studied in this paper is the relationship between static objects and dynamic relationships between objects. A static object is an object that does not have movement. Comparison between one or more static objects can be seen as the relationship between static objects. Determining the orientation, distance measuring, comparing the colour, texture, the location, the shape, direction, and other attributes as an indicator to determine the relationship of static objects [1].

While the relationship dynamic objects to compare two or more objects are dynamic or moving includes directions of movement, locomotion, speed, intersections and collisions [1]. The dynamic object will move in a way and a different direction, change the texture, shape and colour in a way that is orderly and predictable.

2. ResearchMethods

This research is a descriptive exploratory with a qualitative approach. The subjects of this research are three students, each of them has learning style visual, auditory and kinesthetic ability relative same. The subject is SDI AL-Irsyad Kediri, and they used Google SketchUp as geometry media teaching learning.

The spatial representation of the students explored the way students are assigned to draw a cube models, to determine the orientation of students in drawing the next cube models, students are assigned to compare with any other cube models drawn to the orientation of different viewpoints. Students compare shapes, elements owned by the two pieces of the cube models, and the viewpoints of the two models of the cube. Students evaluate, compare and then summed up the results of such comparisons.

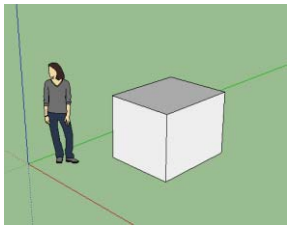
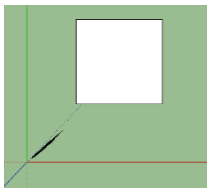
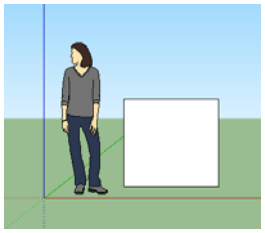
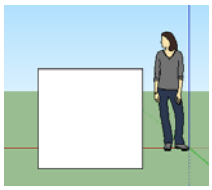
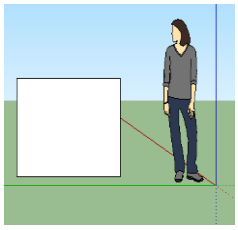
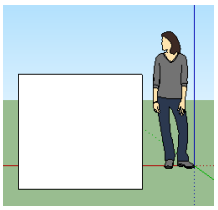
To find out how these dynamic processes of object relationships, students are assigned to analyse two models of the cube rotated in a way and a different direction. Students identify whether by way of rotating the different elements of the two cubes remain and how these relate to the viewpoints of both the cube. The results obtained by these students were exhumed by using direct interviews. Information obtained by investigators then analysed and presented in the form of a description of the representation of students in fulfilling the terms of the two elements of the spatial representation.

3. Result and Discussion

The preliminary studies have shown that every studenthas different kinds of style to construct it and the representation of their understanding. However, it also depends on their habits and experiences. Preliminary pilot studied have been shownin Table 1.

Table 1. Visual, auditory and kinesthetic student representations

Visual Student	Auditory Student	Kinesthetic Student
• Students draw a cube model I using the menus from isometric	• Students draw a cube model I using the menus from the front	• Students draw a cube model I using the menus from the left

Visual Student	Auditory Student	Kinesthetic Student
looks.  (a) • Students draw a cube model II using the menus from the on top looks.  (b) **Figure 1** (a) cubes isometric looks, (b) cubes top looks	looks.  (c) • Students draw a cube model II using the menus from the back side looks.  (d) **Figure 2** (c) cubes front looks, (d) cubes back side looks	side looks.  (e) • Students draw a cube model II using the menus from theback side looks.  (f) **Figure 3** (e) cubes left side looks, (f) cubes back side looks
• Students identify the cube's elements using pictures, more than one picture's model.	• Students identify the cube's elements with images and mention the words.	• Students identify the elements of the cube with pictures and explain it with body movements.
• They mention the elements of thecube by using the pictures more than one picture and accompanied by the necessary words.	• They mention the elements of thecube in detail using words.	• They mention the elements of acube with movement, words and occasionally show a picture.
• In explaining the relationship between these elements, it does not mention the origin clearly due to work according to their intuition.	• They mention the relationship between these elements in detail and clearly	• They mention the relationship between these elements by showing a picture followed by body movements.
• They can rotate the model from different angles and use the toolbar menu to another by using two images for reference rotate the model image.	• They rotate the model image within 2-3 rounds only because sometimes they still confused by references used	• They rotate the model image within 2-3 rounds with theoccasional demonstration.
• They can mention the orientation and direction of the cube which rotated.	• They can mention the rotary directions but sometimes confused to determine its orientation.	• They canmentiongrabbing orientation. To demonstrate and determine the direction of therotary.
• Students conclude elements of cube consistently despite cube rotate objects. The worldview affects the shape of a cube when drawn.	• Students conclude elements of thecube that built from flat elements and perspective of someone that affect the image of acube.	• Students conclude the elements of the cube that did not see all in the picture but depending on someone's perspective on the picture.

4. Conclusion

Arguing from thebasic definition of spatial thinking, they have three basic elements. One of them is representations. Representation has two elements that students able to show it when they construct their concepts. The preliminary studies have shown that every studenthas different kinds of style to construct it and the representation of their understanding. It depends on their habits and experiences. The activities in this research were designed that students able to interact and to handle all of the problemsencounter with their capabilities by using google sketchup and their spatial experiences. They

can handle all of themanipulatives such as how to connect their spatial experiences in the form of apicture (cubes) using google sketchup. The different result showed by visual, auditory and kinesthetic students can be seen on the differences of how they represent their capabilities. To clarify of this research to be useful, it has to be extended into subsequent representation research.

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