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# Profile of biology prospective teachers' representation on plant anatomy learning

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**Abstract.** This study aims to obtaining students' representation ability in understanding the structure and function of plant tissues in plant anatomy course. Thirty students of The Biology Education Department of Sriwijaya University were involved in this study. Data on representation ability were collected using test and observation. The instruments had been validated by expert judgment. Test scores were used to represent students' ability in 4 categories: 2D-image, 3D-image, spatial, and verbal representations. The results show that students' representation ability is still low: 2D-image (40.0), 3D-image (25.0), spatial (20.0), and verbal representation (45.0). Based on the results of this study, it is suggested that instructional strategies be developed for plant anatomy course.

## Introduction

Representation is the ability to describe or stimulate some ideas, events, concepts or objects and processes [1-3]. Representations are related to interpret and build relationships between objects, representations, and meaning [4]. The representations are importance in science [1] and It is something which is very important in understanding of plant anatomy structure [5,6]. Representation can also be a symbol to describe an object to a person or a learner. In studying science, students must learn how to use representation as a means of thinking to understand, predicting not merely memorizing in understanding the concept [7].

Plant anatomy describes the structure and organization of the cells, tissues, and organs and their functions relate to plant development [8-10]. The structure of cells and tissues are three-dimensional (3D), microscopic, and abstract structure. The demands of the plant anatomy syllabus requires students to understand the structures of cells, tissues, or organs of plants, which are 3D structures; meanwhile, the structure of plant tissues can be observed only in the form of two dimensional (2D) using microscope. In addition, in plant anatomy subjects, students are required to be active in constructing knowledge in the form of concept change. Students need to recognize the characteristics of plant tissue (for example, the shape, size, positions, cell wall thickness, air cavity, and another characteristic) and to relate it to its function [6]. So according to this structure characteristics and demands of plant anatomy syllabus, students must make representation in verbal, visual, and spatial. Therefore, it is necessary for student to be able to make representation of real structure in 3D structure [5]. By making a representation, students are expected to understand the concept especially related to the characteristics of tissues structure more fully.

The previous research about representation have shown that the representation can improve student performance in learning, improve motivation, creativity, and student learning outcomes [11]. Using visual representations in science increase the students' understanding especially in visual representation [1,12-14] and visuo-spasial representation [5,6,15]. Visual representation, in the form of 3D objects, is

a very important part of understanding the phenomena in biology and mechanics and in solving spatial problems [16]. In the plant anatomy classroom, visual and spatial representation are especially helpful when representing the structure and functions of the cells, plant tissues that are microscopic and abstract [5,6]. Visual representations play a critical role in the communication of science concepts for scientists and students alike [12]. Visual representations are play an important role in communicating knowledge of science concepts to students [12].

Spatial ability is an important skill in various activities in daily life and it is very fundamental ability in 21st century [17]. Spatial representation is an important skill that helps the student to solve spatial problem, particularly manipulate and transform 3D object in brain [18], and helpful when representing the structure spatial abilities are powerful tools for understanding and solving sciences problems, for example, Watson and Crick's discovery of the structure of DNA [19]. Furthermore, verbal representation is useful in providing definitions of a concept, whether oral or written. Verbal representation is also useful for expression of the meaning of the concepts of science with all its limitations and shortcomings. The image representation is useful to help visualize an abstract concept. In plant anatomy the concept of the structural characteristics associated with the shape, position, size, and thickening of the cell wall is more appropriately expressed by using images rather than verbal.

Previous research related to plant anatomy also revealed that in order to understand the concepts of plant anatomy intact, spatial thinking ability [20], logical thinking [6], framing [5,6] and high reasoning [5]. Building a 3D structure of plant tissue with the Wimba model can enhance students' conceptual understanding of structure and function [21]. Previous research results also show that students' spatial thinking ability can be improved in building 2D, 3D, and 3D wake-up images. However, this research also reveals the low ability of students in managing representation and performing representational transformation [5,6]. Based on these findings, it is necessary to review how the representation of 3D images that students built. So this paper focuses on the discussion of student' representation in plant anatomy and related to spatial ability. Students' representation focuses in four categories: 2D-image, 3D-image, spatial, and verbal representations. The results of this study are expected to be used as additional data in overcoming the weaknesses in previous research. In addition, the research is also expected to be used as a basis in developing anatomy lecture program that can improve student representation ability, especially representation of plant tissue structure in 3D.

## 2. Research method

### *2.1 Participants*

This research is a descriptive research. Thirty students, 27 females and 3 males, of Biology Education Department of a state university of South Sumatera was participated in the study. The Participants were the students who have taken plant anatomy course.

### *2.2 Instrument Test and Procedure*

The instrument used in this research was developed by the researcher. The instruments were validated by experts and through field trials. The instruments were designed to investigate students' representation related structure and function of Plant Anatomy, namely 2D-image, 3D-image, spatial, and verbal representations.

The 2D and 3D-image test consists of 10 item in essay. It was referred to students' ability in constructing the plant tissue structure from 2D images into 3D images or vice versa. Spatial representation test consists of 15 item test in multiple-choice questions form. This instruments was specifically designed for this study and it was employed four indicator, namely: (1) generate a representation; (2) manage and maintain representation in working memory, (3) scanning the maintained representation in working memory; and (4) transform a representation with rotation or view the object from a different perspective [22]. Meanwhile, verbal representation consists of 20 item test in multiple-choice questions form and developed based on Marzano's framework [23]. Data were analyzed with students' scores in four categories of representations: 2D-image, 3D-image, spatial, and verbal representations. Category of Representation score are very high (75-100); High (67-74); Medium (51-60); Low (35-50); Very Low (≤34) [24].The data obtained are then analyzed quantitatively.

## 3. Result and Discussion

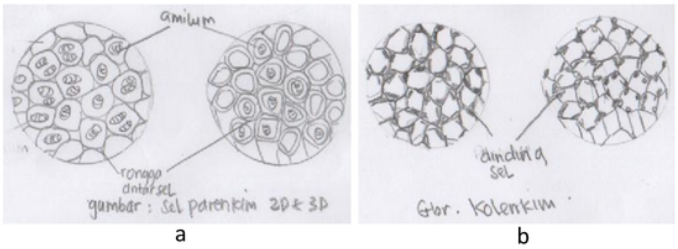
This study aims at obtaining students' representation ability in understanding the structure and function of plant tissues (parenchyma, collenchyma, and sclerenchyma) in plant anatomy course. The results show that students' representation ability is still low on all indicators (Table 1).

**Table 1.** Score of microscopic representation.

| Representation | Score | Criteria |
|---|---|---|
| 2D-image representation | 40.0 | Low |
| 3D-image representation | 25.0 | Very Low |
| Spatial representation | 20.0 | Very Low |
| Verbal representation | 45.0 | Low |

*Note: Very high (75-100); High (67-74); Medium (51-60); Low (35-50); Very Low (≤34)*

The data on Table 2, showed that the higher score of students' representation ability was verbal representation (45.0), and the lowest score was spatial representation (20.0). This study also showed that 3D-image representation and spatial representation in very low category. The observation results in the classroom, showed that student was difficulty in constructing the structure of 2D to 3D representation. According to personal communication with students, it is known that to create a 3D representation structures students must be able to manage and maintain 2D (transverse and longitudinal microscopic observation) representation by recognizing the characteristics of each tissues by scanning the shape, size, position, and location of the tissues to incorporate them into images 3D. This is in accordance with previous research that students have difficulty and have the lowest ability on maintain representation and make representational transformation indicators [5], because this processes are complex process in which students have to store information about the shape, color, or position of a network while processing information to create a logical connection between two images (transverse and longitudinal). This means the students coded visual and spatial information obtained and re-coded to produce mental representation. This result are also supported on other previous studies, that showed to constructing and understand 3D structure and spatial thinking related to plant anatomy concepts requires higher order thinking skill and reasoning ability in formal operation stage [5,6].




a b

**Figure 1**. Example of student 2D-image and 3D-image representation in plant anatomy.

In contrast to constructing 3D-image representation capability, the ability to analysed parts of structure with verbal representation, showed that students were able to analyse the characteristics of plant tissue structure through 3D-images better than 2D-images. The actual shape of plant tissue is more clearly in 3D images, so it was easy to remember and described by students. While in 2D, it illustrates one side of the tissues and not the whole tissues form so that students have difficulty to describe the shape of the tissues properly. Characteristics of tissues structure in 3D-image expressed by students more clearly related to the shape of cells, positions, and parts of the tissues.

In addition, result of the research was showed that students can construct a representation to the full on the parenchyma tissues and decreases in the collenchyma and Sclerenchyma (Figure 1). These results are also supported by some results on previous studies that showed student was difficulty in constructing the structure of 2D to 3D or otherwise because this structure was microscopic and abstract [5,6]. In

addition, the collenchyma and sclerenchyma have more complex structure if compared with parenchyma. Collenchyma and sclerenchyma have thickening in their cell walls, so students have difficulty to recognizing the real form of the tissue. Overall, however, it is necessary to improve students' understanding of the structure of parenchyma, chollenchyma and sclerenchyma tissues.

The results of previous studies also suggest that constructing 3D structures is a complex task of working memory [25], and involves complex cognitive processes [26]. According to this [27], a complex working memory task occurs when one has to store information while processing other information simultaneously. The ability of a person to store information processing can be reduced due to situational factors such as lack of sleep or fatigue of cognitive fatigue [28]. Another theory also reveals that cognitive training can improve the performance of working memory [29,30]. It begins by collecting visual and spatial information through scanning, and makes the focus of observation on the characteristics of each tissue to build logical relationships in 3D-image. This is in accordance with the disclosed by [25], in building the 3D-image structure the students should pay attention to the characteristics of 3D shape, focus on a particular part of the existing characteristics, and connect the 3D shape with the characteristics of the object. Therefore, it is necessary to design anatomical learning of plants that can improve the efficiency of working memory by giving cognitive process gradually so as to reduce the cognitive load of students.

## Conclusion

In the study as indicated, most of students have low in fourth category representation. The results show that students' representation ability is still low: 2D-image (40.0), 3D-image (25.0), spatial (20.0), and verbal representation (45.0). Based on the results of this study, it needs to repair the strategy to improve spatial ability in anatomy learning. It is suggested that instructional strategies be developed for plant anatomy course. Therefore, it is necessary to design anatomical learning of plants that can improve the efficiency of working memory by giving cognitive process gradually so as to reduce the cognitive load of students.

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