Students’ visual-spatial ability in representing single cell epidermis of *rhoeo discolor* leaf

H Azalia*, A Rahmat and E Nuraeni

Program Studi Pendidikan Biologi, Sekolah Pasca Sarjana, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia
Departemen Pendidikan Biologi, Fakultas Pendidikan Matematika dan Ilmu Pengetahuan Alam, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia

*adirahmat@upi.edu

Abstract. The one of the way to study plant anatomy was taught by observation from microscopic object and represented visual-spatially. This study was focused on students visual spatial ability in representing single cell epidermis of *rhoeo discolor* leaf. It was conducted with 44 undergraduate students who presently enchanting Plant Anatomy. Data was collected using visual spatial worksheet and questionnaire. Students was representing cell in three activities: (1) visual representation of two dimensional (2D) on transverse, longitudinal and paradermal incision of epidermis cell; (2) visual representation of three dimensional (3D) that represents three types of incision; and (3) spatial representation by constructed 3D model of single cell based on microscopic observation. Several types representation of the plant cell structure was observed. There are significant correlation between students ability to representing microscopic object in 2D to 3D ($r=0.504; p<0.05$) and representing 3D to 3D model of cell ($r=0.460; p<0.05$), but there is no significant correlation between students ability in representing 2D to 3D model of cell ($r=0.288; p>0.05$). The result shows, there is scaffolding correlation between visual representation ability to spatial representation ability. Several factors are supposed to affect the correlation between students visual spatial ability will be explain further in this article.

1. Introduction

Plant Anatomy is one of the obligatory subjects that must be done by undergraduate biology students. The focus subjects in plant anatomy includes the development of cell structure, plant tissues and plant organs[1] [2]. Observation of microscopic preparations by using microscope is the one way to learn plant anatomy. Through observation, students must be able to identified, and generalizing characteristic of microscopic object of plant structures. Students also conduct plant anatomical studies through two-dimensional (2D) images from the teaching materials [3].

In fact, the students only guided to understand the stucture of plant anatomy through their drawing in 2D and writing the information of it. In our theoretical part and practical work activity, students only require to visualizing the stucture and function of cells and tissues in 2D. The student needs to be guided to visualizing it in three-dimensional (3D) structure[4].

Preferably, students prepared to understanding plant anatomy in 3D structure with concern to proportionality, accuracy of the scale, using spatial ability and having the sense of scale for anatomical concepts, therefore student be able to understand cell structure in a different perspective [5].
In reality, students have difficulties to learn the structure and the function of molecular and cell level. Those problems related with the ability to imagine 2D structure which are presented in their books to be 3D structure in the actual shape and size [6]. In spite of, it takes a good imagination to represent structure, position and function of plant cell [7].

The ability to process visual and spatial information is very dependable in our daily life [8]. The visual-spatial ability is defined as basic ability that human possess to acquire knowledge [9]. The criteria of good spatial thinking process has been investigated previously by [4]. The result show that the students be able to construct a complex 3D structure, specifically drawing the result of microscopic observation in 2D and 3D proportionally [4]. Proportionality of 2D and 3D images is determined by quantitative aspect, such as the length and width of the cell from measurement results can help students to make a model of cell proportionally based on the observation completely and well-ordered [5]. The ability to represent one cell is needed by potential biology teacher. Therefore, the biology educator need to be prepared by ability to review the structure of the high-tech micrograph from research in 3D with perfect scale [10].

This research focus to students visual-spatial ability to represent single cell of epidermis in *Rhoeo discolor* leaf and reveal any possible factors which can be affected difficulties of student in representing from visual to spatial.

2. Method

In order to described the ability to representing microscopic observation in visual-spatial from single cell epidermis of *Rhoeo discolor* leaf, we develop visual-spatial worksheet. In this worksheet students was representing cell in three activities: (1) visual representation of two dimentional (2D) on transverse, longitudinal and paradermal incision of epidermis cell; (2) visual representation of three dimentional (3D) that represents three types of incision; and (3) spatial representation by constructed 3D model of single cell based on microscopic observation. After the students drawing their representation, the questionaire was given to identify students difficulties in representing microscopic object from visual to spatial and to reveal any possibly obstacle while the process of representation.

This descriptive research was involve 44 students (39 females and 5 males) who take plant anatomy course. Quantitative data was analyzed by correlation of the ability to representing microscopic object become 2D images, 3D images and 3D models, whereas qualitative data is the type of students visual-spatial representation. The visual-spatial ability in representing single cell was categorized by reference and modified from [11] that is: 75-100 (very high); 61-74 (high); 51-60 (medium); 35-50 (low); and ≤ 34 (very low)

3. Result and Discussion

Figure 1. The Photo of Observation Result from Fresh Preparations Using Hand Section of Epidermis Cell in Rhoeo discolor Leaf: A=Paradermal Incision, B=Longitudinal Incision, C=Transverse Incision

Figure 1 shows the results of observation in variety way slide incision of epidermis cell. The visual-spatial ability are vary as seen on Table 1, Table 2 and Table 3. We found four type students representation in representing single cell epidermis of *Rhoeo discolor* leaf.
Table 1. Students visual representation in two-dimensional (2D)

<table>
<thead>
<tr>
<th>Incision</th>
<th>Precise Shape</th>
<th>Acute Shape</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal</td>
<td>18%</td>
<td>55%</td>
<td>73%</td>
</tr>
<tr>
<td>Transverse</td>
<td>43%</td>
<td>32%</td>
<td>75%</td>
</tr>
<tr>
<td>Paradermal</td>
<td>89%</td>
<td>11%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 1 shows the different of student visual representation in 2D while representing epidermis cell. This difference is due to the way students drawing and students visual representation ability are diverse. There are three types visual representation while observing the longitudinal incision. There are 55% students that representing in the less precise shape, ie hexagonal with the upper and the bottom are acute (Table 1). In transverse incision also there are three types representation. The students who representing cell precisely is 43%. In paradermal incision, 89% students able to drawing the epidermis cell precisely too. In plant anatomy, students must managing a representation ability to constructing two dimensional images from the photo object of observation [4].

The appropriate 2D representation criterion are in case that students be able to: 1) created a 2D images that corresponding to the photo of microscopic objects; 2) the cell size proportionally from measuring the cell size using micrometer stage; 3) the position of the cell accurate; and 4) the images information complete and precisely according to the concept itself. The visual representation in 2D shows polihedral shape with the upper is flat and the bottom is acute with the thin cell wall. If the epidermis cell seen from the surface then we will see the rectangulat to poligonal shape, dense and thin cell wall [12].

There are four type visual representation in 3D that shown in Table2. There are 32% students that representing cell in 3D precisely in Type 1 and 74% student find it difficult while drawing 2D to 3D. The difficulty in making the imagination of 3D gave impact to the low representation ability which also due low concept achievement in plant anatomy [7]. The students of 3D images shows unpropriate between 3D images and 2D images with unproportionally cell size. It infers that to make an 3D images precisely and proportionally needs to pay attention between 3D images with the third 2D images that has been made before. The students need to make incision from different types of incision to get the full imagine shape of single cell epidermis [4]
Table 2. Students visual representation in three-dimensional (3D)

| Type 1: flip over hexagonal pyramid (the bottom side is acute) 32% |
| Type 2: hexagonal pyramid (the upper side is acute) 2% |
| Type 3: hexagonal pyramid with the bottom and upper side are acute 32% |
| Type 4: hexagonal 3D (the bottom and upper side are flat) 34% |

Tabel 3. Students spatial representation in 3D model

| Type 1: flip over hexagonal pyramid (the bottom side is acute) 23% |
| Type 2: hexagonal pyramid (the upper side is acute) 34% |
| Type 3: hexagonal pyramid with the bottom and upper side are acute 41% |
| Type 4: hexagonal 3D (the bottom and upper side are flat) 2% |

Table 3 shows the students spatial ability through construction 3D model of cell epidermis. There are 23% students which constructed the model precisely (Type 1) and the other find difficulties while constructing 3D model if the 3D image that they made before didn’t fit precisely. This result shows that the drawing technique is relatively low. It shown from the using of dotted line in 3D images has not been used properly. Beside of that, student find difficult to constructed the 3D model if only see the 2D images.

Graph in Figure 2 shows us that 25% student feel easy to draw 2D images if the photo based on observation is focus and clearly. It is seen from the proportional of 2D images with the accurate size. For students, learning plant anatomy by representing cell in 2D and 3D able to facilitate learning style
students, especially visual learning style and help students to understand structure concepts of the plant cell. There are 52% students feel quite difficult in representing cell visual-spatially. The difficult thing is to imagine and draw cell if only from one perspective. According to the students, for be able to imagine the 3D structure need minimum two different perspective, such as the cross section of longitudinal and transverse preparation.

Graph in Figure 2 shows us that students have good ability to understand 3D cell structure of plant cell. In learning, students not only guided to understand 2D structure, but also in 3D structure. That analysis results show that 89% students have very good spatial ability. The appropriate 3D representation criterion are in case that students be able to: 1) constructed 3D models that is prportional in size. 2) The shape is corresponding to the 3D images before photo; and 3) the position of the cell accurate.

Table 4 shows that there are significant correlation between students ability to representing microscopic object in 2D to 3D (r=0.504;p<0.05) and representing 3D to 3D model of cell (r=0.460;p<0.05), but there is no significant correlation between students ability in representing 2D to 3D of cell (r=0.288;p>0.05). This result show that contribution the ability of representing 2D to 3D is 25% whereas 75 % contribution 2D to 3D is affected by another factors.

From that results, we know that students able to constructed 2D images become 3D image, but the students cannot create the 3D model with only see the 2D images. It infers that there is scaffolding correlation between visual representation ability to spatial representation ability. So, the students need to constructed 2D images then constructs 3D images while constructing 3D model.

Factors are influence the difference type of students visual-spatial representation, there are: 1) students understanding about drawing techniques not good enaough. It seen from the using of dotted line in 3D images has not been used properly; 2) The activities of drawing 2D-3D and model 3D are held with group discussion (Focus Group Discussion), by working with the groups, student disposed to rely on only to the cleverest one. Each groups only use one photo observation source. They didn’t do the sharing data. So, there no quality control process of their quality of objek microscopic. The students representation not only influence from the observation result and from group discuss but also influence from class discussion. Based on observation, inform that only student who have good visual-spatial ability that involved actively in class discussion such as giving an arguments and asking a question. 2) The photo of microscopic object need to be more representative and precisely.
4. Conclusion
The result shows that there is scaffolding correlation between visual representation ability to spatial representation ability. Several factor can influence the relation students visual-spatial representation, such as drawing technique, focus group discussion and Several factors that are thought to influence the relationship of visual-spatial representation of students, namely drawing techniques, FGD and quality of the photo from microscopic objects.

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6. References