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Research Article

Deep Learning in Biology: 3D Representation of Online and Reality

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ABSTRACT

Deep learning is required to examine biological material, particularly abstract content, either in the laboratory alone or with internet literature. This study aims to compare the effectiveness of learning through practicum versus learning through a combination of practicum (real-world data) and online literature review in terms of the ability to represent the three-dimensional (3D) model of plant tissue structure in a plant anatomy course. This study employed a quantitative approach with a quasi-experimental design in the posttest alone control group. This research used Purposive sampling to choose the research sample, which consisted of two classes of students enrolled in a plant anatomy course. ANOVA was used to analyze the data, with a significance level of 0.05. The results indicated a significant difference in learning when combined practicum was with online literature study visuospatial when practicum was used alone with a more excellent 3D model representation value in the class. Classes that combine an applied practicum with an online literature review have a grade point average of 73.61.

***Keywords**: practicum method, online literature review, 3D model representation, plant anatomy*

Background

Biology is a data-intensive science, yet its data are often complex and difficult to comprehend. As a result, deep learning approaches may be ideal for resolving issues in this field (Ching T et al. 2018). Deep learning has been widely applied (Perrotta & Selwyn, 2019); deep learning resolves the primary difficulty associated with learning representations stated in other, simpler kinds of representation. Deep learning enables computers to decompose complex notions into simpler ones. (2016) (Goodfellow et al.). Systems that utilize 2D views of 3D data outperform voxel-based (3D)

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deep models in performance (Ioannidou et al., 2017).

In biology, knowledge is primarily transmitted visually (2D), which is straightforward, yet this information can occasionally produce mistakes, particularly for abstract information. 3D modeling using 3D applications is a form of deep learning that can help develop one's visuospatial abilities (Suprapto, 2018). Deep learning can be used in applications to anticipate the associated consequences at each application exploration data point. It is a sort of clustering that seeks to summarize, explain, or uncover noteworthy patterns in data sets (Ching T et al. 2018). Deep learning approaches have been used in biology, particularly in the health sector, for biomedical applications (Wainberg, 2018), cancer genome information (Chiu et al., 2019), genomic modeling, including the prediction of the effect of genetic variations on gene regulation mechanisms such as accessibility and DNA splicing (Eraslan, Avsec, Gagneur, 2019), and many others. However, plant anatomy has not been widely published, even though few people understand it well. Understanding plant anatomy is critical since it serves as the foundation for botany, tissue culture, physiology, agriculture, plant arts, ecosystems, and environmental science. Students must acquire extensive knowledge of plant anatomy to grasp the structure and function of plant cells, tissues, and organs (Barclay, 2002; Rudall, 2007; Evert, 2006).

Students must acquire extensive knowledge of plant anatomy to grasp the structure and function of plant cells, tissues, and organs (Barclay, 2002; Rudall, 2007; Evert, 2006). Plant anatomy contains a wide variety of components, one of which is plant tissue. According to the analysis, the substance of plant anatomy is divided into three categories: ground tissue (parenchyma, collenchyma, and sclerenchyma), dermal tissue (epidermis and its derivatives), and vascular tissue (xylem and phloem) (Rudal, 2007; Evert, 2006; Tasmania dan Ermayanti, 2013). Students must not only comprehend information and concepts but also be able to express images in two-dimensional (2D) and three-dimensional (3D) formats using a variety of applied approaches, such as the practicum and literature review. Students must enhance their reasoning skills during the learning process by constructing the actual structure of plant tissues in 3D objects, even though what is observed in practicum activities is only in 2D. (Ermayanti et al., 2016). Students must, of course, be able to examine and represent a whole plant tissue model under microscopic conditions, particularly plant tissue (Lugyastyono, 2013). However, due to the microscopic size and abstract nature of plant tissue models, it is not simple for students to see them during the learning process (Suprapto et al., 2012). Another element that may impair students' comprehension of their object representations is the quality of the thick preparations and inaccuracies in identifying plant tissue features.

To assist students in comprehending the plant tissue model, they can view examples of visuals contained in numerous handbooks, which are often in 2D format. Suprapto, 2012; Lazaroqitz & Naim, 2013). (Ermayanti et al., 2015; Suprapto, 2012; Lazaroqitz & Naim, 2013). The literature has not aided students sufficiently in representing the complete structure of plant tissue to the point where they can abstract up to a 3D model because at this stage. Students must understand the structure of plant tissue by identifying its shape position relative to other tissues, the composition of cell wall thickening, the presence or absence of intercellular space, and other characteristics through microscopic observation and comparison with other tissues (Barclay, 2002; Rudall, 2007; Evert, 2006).

Based on the results of the initial field observations, the Plant Anatomy course's learning process has been unable to properly create a representative model of plant tissue in a 3D model. It has remained focused on microscopic observation activities (practicum) without making any additional effort to compare its findings to other references. The images of students' 2D and 3D are still incorrect in labeling each part of plant tissue and describing detailed characteristics of plant tissue. For example, assuming the same shape of plant tissue when viewed from above (cross-section) and the side (longitudinal incision) indicates that students' spatial thinking skills still need to be developed (National Research Council, 2006; Diezmann & Lowrie, 2012).

The application of the practicum method with an image deductive approach to the Wimba learning model has been implemented in Biology education students, namely by beginning with theoretical lectures, followed by practicum observation of microscopes, and then by students creating 3D construction images following microscopic observations. While this effort demonstrated strong conceptual mastery, the outputs of the 2D and 3D drawings remained very low (Suprapto, 2018). It can occur when students lack a reference image to determine whether or not the 3D image they created is correct.

In light of the preceding issues, it is necessary to develop another method that is expected to improve the representation ability of student plant network 3D models. One such method is deep learning with practicum and online literature review to compare the 3D model with the 3D application. The findings of this study are likely to result in the development of alternate strategies for addressing difficulties associated with 3D model representation in the Plant Anatomy course. Additionally, this research is planned to serve as the foundation for developing a Plant Anatomy lecture program aimed at improving students' ability to depict 3D models, particularly in plant tissue.

Methods

This study used the experimental method, and the research design was quasi-experimental with a post-test-only control group. The study population consisted of three classes of fourth-semester biology education students at a university in West Java, Indonesia. Purposive sampling was used to choose the research sample, which consisted of two classes: the control class, which used the practicum technique (real-world data), and the experimental class, which used the practicum method and an online literature study (Figure 1).

E	: X ______	O_1
K	: ______	O_2

Symbol:

E : Experiment group
K : Control group
01 : Postest in the experimental class
02 : Postest in the control class
X : treatment using practicum method and online literary review

Deep learning was conducted in both sessions utilizing the Wimba learning model and a deductive method that begins with creating a concept map before class. The lecturer discusses and provides feedback on the concept map's outcomes throughout the class. At the following meeting, practical activities were conducted using a microscope to examine cross and longitudinal sections of a plant tissue structure (ground tissue, dermal tissue, and vessel tissue). The results are converted to a 3D image and model using the 3D Blender tool (Figure 2). Previously, pupils received training on how to use the 3D Blender application, which simplified creating 3D representations (Muniasamy and Alasiry, 2020). Students, particularly in the experimental class, can evaluate 2D and 3D photographs from other internet references, either of the same or different species. We will utilize this online literature research to create 3D images and models (Figure 3).

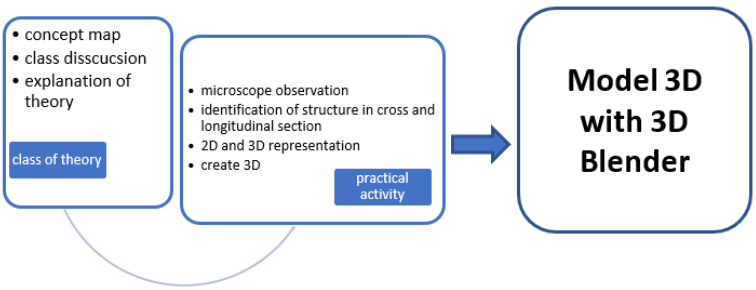


Figure 2. Wimba's learning steps use a deductive approach and use practicum methods

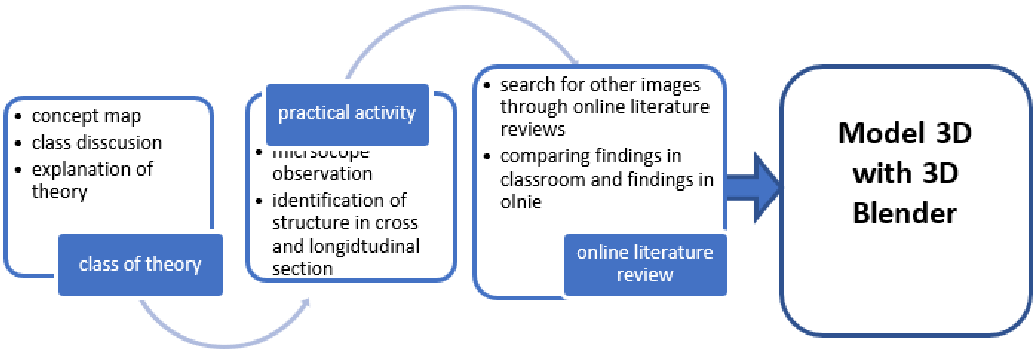


Figure 3. Wimba's learning steps take a deductive approach and use practicum methods and online literature review

The instrument utilized in this study is a three-dimensional model product evaluation rubric derived from Starko (2006) and Bobek and Tversky (2016), which includes components for tissue shape, tissue size, tissue position within an organ, and a label description of plant tissue. The analysis technique employed in this study includes a battery of tests, including the homogeneity test and hypothesis testing. Homogeneity testing is used to determine whether the acquired data's variance is homogeneous. This homogeneity test uses Levene's test method with the SPSS application. If the significance value is more than 0.05, the variance of two or more data population groups is said to be homogeneous. Additionally, the researchers used the SPSS application to test hypotheses using 1-way Anova, a parametric statistical test that determines whether there is a difference in the averages of two sample groups. If sig: p 0.05, there is a difference at the sig level of 5%.

Results and Discussion

Following treatment in the experimental class, the data is given using a practicum approach mixed with an online literature study. The results indicated that the average score for 3D models created by students in the experimental and control classes was 73.61 and 64.25, respectively (Figure 4).

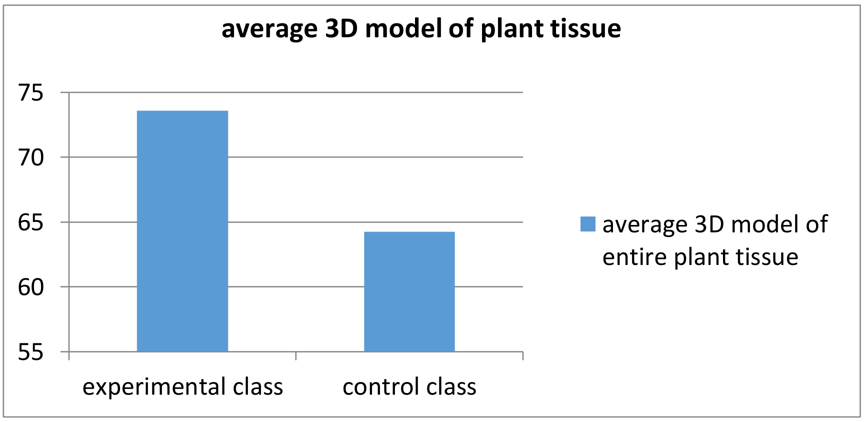


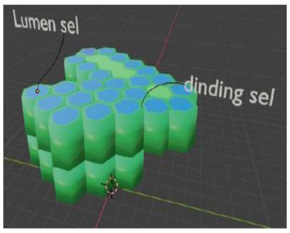
Figure 4. Average values of the 3D model of all plant tissues in the experimental and control classes

According to table 2, the significance level is 0.013. As a result, if p = 0.0130.05, H0 is rejected, and Ha is approved. May state that the results of the 3D model representation differ between classes that use the practicum model alone and classes that use the practicum model in conjunction with an online literature review. According to Figure 4, the class that uses the practicum technique in conjunction with an online literature review achieves a higher grade than the class that uses the practicum method alone, which is 73.6.

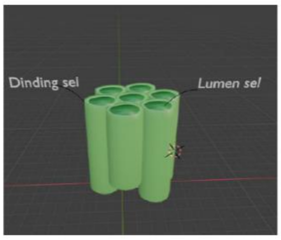
Table 2. One way ANOVA Hypothesis Test

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1050.660	1	1050.660	6.635	.013
Within Groups	7283.788	46	158.343		
Total	8334.448	47			

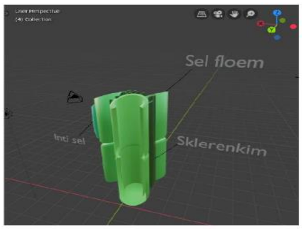
Visuospatial-based learning, also known as the Wimba model, focuses on students' capacity to depict two-dimensional models in three dimensions using their imaginations in conjunction with appropriate learning methods. The practicum method, or microscopic observation, is one of the most often used techniques for obtaining the appearance of a genuine object from plant tissue. Students must be able to create a three-dimensional model using observations of two-dimensional items in the form of a cross and longitudinal sections in this scenario. According to Bobek and Tversky (2016), visual (2D) explanations of diverse phenomena should be an effective method for students to develop their spatial thinking abilities, hence boosting the effectiveness of these explanations while also increasing spatial abilities.



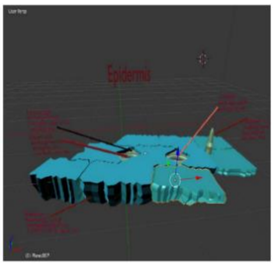
(A)



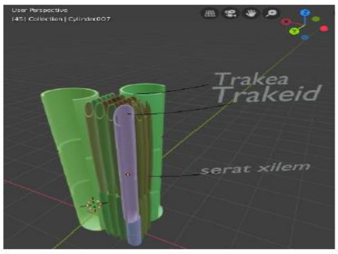
(B)



(C)



(D)

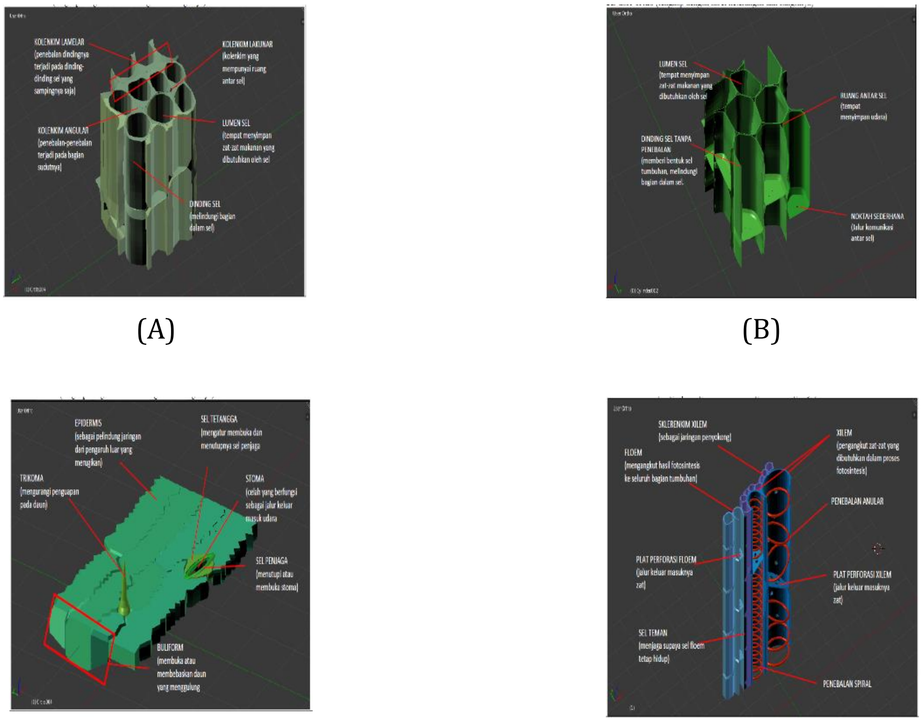


(E)

Figure 5. 3D model of collenchyma (A), parenchyma (B), xylem (C), epidermis (D) and phloem (E) tissue in a control class applying the practicum method (reality)

When the instructor observed pupils using a microscope, the results indicated that, on average, the student's skills in preparing preparations were still insufficient, as incisions were not thin enough (in general, they had difficulty when doing longitudinal section). As a result, the visual data (2D) information contained in the laboratory results is insufficient. As a result, the outputs of students' 3D microscope representations are less precise in size, shape, placement, and tissue labelling, as they are adjusted only during practicum (Figure 5).

The results of the 3D model representation of students who used the practicum method and conducted an online literature review are generally superior to the shape, size, location, and labelling of the plant tissue is correct. Because, even if the findings at the practicum are not as good as they could be due to the poor quality of the incisions and preparation skills, students can look for additional references online to compare to their findings during practice. Even if the online model findings are for different species, we can utilise this to demonstrate to students how to interpret the 3D model by laboratory findings (Figure 6).



(A) (B) (C) (D)

Figure 6. 3D model of collenchyma (A), parenchyma (B), epidermis (C) and xylem-phloem (D) tissue in an experimental class that applies the practicum method (reality) combined with an online literature review

Practicums can help students improve higher-order thinking abilities (Torres, 2018). Because practicum involves cognitive processes such as hypothesis testing, reading source material, analyzing data, interpreting outcomes, writing with discipline, and collaborative effort." (2012) (Goldey et al.). The plant anatomy practicum process involves preparation, microscopic observation, classification of cells and tissues that are abstract images, decision-making training, and improvement of students' science process abilities. The visuospatial capacity, as assessed by the ability to represent three-dimensional objects in three dimensions, is technology-dependent. Adaptive learning technology will produce a fully individualized environment with content that not only changes but is also created in response to students' unique demands (Muniasamy and Alasiry, 2020). The results indicated that the practicum technique was still insufficient to offer sufficient information, and that online sources were required to fill in the gaps. Additional online 2D data in the practicum serves as student validation of insufficient data and assists students in refining their data to create 3D models. Deep learning in 3D is extremely useful for students, as it can help them enhance their visuospatial abilities and memory (Burggraafa et al., 2018), reasoning (Suprapto et al., 2019), and creativity (Suprapto et al., 2018). Complete knowledge enriches one's imagination and improves 3D representations because students can access the appropriate online information sources to fill in gaps and accomplish their learning objectives (Muniasamy and Alasiry, 2020). Ioannidou (2017) asserts that an approach that use numerous 2D perspectives to represent 3D has a minimal advantage over one that employs full 3D geometry. A recent study demonstrated that a model could attain greater results. 3D. Another advantage of deep learning in 3D plant anatomy is that it aids in the solution of numerous problems in the disciplines of physiology, botany, and agriculture. Additionally, deep learning can benefit the development of eLearning by enhancing the classification of content elements since digital learners increasingly want the content to be available in various formats and across various platforms. Deep learning occurs independently in the eLearning sector, from extracting and assessing data sets from the LMS to forecasting what online learners require based on their previous performance. A. Muniasamy and A. Alasiry (2020).

Conclusion

Deep learning with practicum (real-world data) and online data on the Wimba learning paradigm can develop visuospatial skills and demonstrate significant differences in results. Deep learning in the Wimba learning model used in the Plant Anatomy course demands a large amount of data to convert 2D to 3D and produce a more accurate 3D representation. Because future deep learning would require a large amount of 3D information, it is recommended to improve 3D representation.

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