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Understanding the Macroscopic, Microscopic, and Symbolic Levels of Angiosperms through SiMaYang Type II Learning

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Abstract

This study aims to analyze the effectiveness of the Si-Lima Layang-layang (SiMaYang) type II learning model on Angiosperms material on understanding the macroscopic, microscopic, and symbolic levels. This study was a pretest-posttest multiple group design experiment. The effectiveness of the learning model was measured by the N-gain score of the angiosperm test. Hyphothesis was tested using Manova (Multivariate Analysis of Variance) with SPSS. The result of the analysis is the sig value. 0.010 < 0.05, which means that there is a significant difference in understanding the macroscopic level between the SiMaYang type II class and the Discovery Learning class. Sig value. 0.016 < 0.05, which means that there is a significant difference in understanding microscopic level between the SiMaYang type II class and the Discovery Learning class. Sig value. 0.396 > 0.05, which means that no significant difference level of understanding the symbolic between the SiMaYang type II class and the Discovery Learning class. It can be concluded, SiMaYang type II is effective in improving understanding at the macroscopic and microscopic level, but not for the symbolic.

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INTRODUCTION

Biological studies consist of a representation level that functions as an understanding of natural phenomena, namely (1) a macroscopic level where the biological structure can be seen by the naked eye; (2) the cellular or sub-cellular (microscopic) level where the structure can only be seen under a light or electron microscope; such as cells, tissues, DNA, protein, and various kinds of biochemistry, for example, biochemistry can be identified using electrophoresis, chromatography, and centrifuge, or other analysis tools; and (3) the symbolic level that provides a mechanism for explaining phenomena represented by symbols, formulas, chemical equations, metabolic pathways, numerical calculations, genotypes, inheritance patterns, and phylogenetic trees in evolution (Tsui & Treagust in Papatheodosiou et al., 2020; Torkar et al., 2018).

Ideally, students can master all three levels of understanding, both macroscopic, microscopic, and symbolic. However, based on the research, it was found that students' lack of understanding at the microscopic level such as understanding, analyzing, describing microscopic structures and explaining their functions and processes (Kusumawati, 2016; Sitepu, 2019), macroscopic and symbolic levels, namely the difficulty of analyzing morphological features and compiling classifications (Zarisma, 2016; Mulyani, 2017). Similar conditions exist in field studies conducted by researchers in class X MIPA students of SMA Negeri 1 Warureja in the 2019/2020 academic year. As many as 71.1% of students who completed the KKM at the macroscopic level sub-material, 46.9% of the students who completed the microscopic level sub-material, 34.7% of the students who completed the symbolic level sub-material, and 50.3% students who completed the macroscopic-microscopic sub-material level. The lowest percentage of KKM completeness is owned by the Plant World material, with details of 11.6% of students who completed KKM in the Characteristics & Kinds of Plants sub-material and 16.3% of students who completed KKM in the Plant Reproduction and Classification sub-material.

One of the subjects in the plant world is Angiosperms. Based on research conducted by Sulistyawati et al. (2019) and Purnamasari et al. (2014), students have difficulty learning angiosperms, for example in the section on distinguishing Liliopsida and Magnoliopsida. Angiosperms were chosen because there are macroscopic aspects such as morphological characteristics and roles. Microscopic aspects of angiosperms are multiple fertilization and vascular bundles as well as symbolic aspects such as the arrangement of the key of determination and cladogram.

To overcome the problems that have been described, we need a lesson that facilitates direct observation, imagination through pictures, contains a scientific approach, and accommodates the three levels of understanding. One solution that can be done is to use the Si-Lima Layang-Layang or SiMaYang model. The SiMaYang learning model affects students' ability to present levels of scientific phenomena, namely macroscopic, microscopic, and symbolic. The SiMaYang model consists of 4 steps, namely orientation, exploration-imagination, internalization, and evaluation. Initially, this model was developed to be applied to students. However, considering the characteristics of high school students and students are very different and the 2013 curriculum applies a scientific approach, so the SiMaYang learning model is adapted to existing conditions.

The scientific approach involves the 5M learning experience, namely observing, asking questions, gathering information, associating or processing information, and communicating. This 5M learning experience is integrated into the SiMaYang learning syntax explicitly. The results of this model improvement are called SiMaYang type II (Afdila, et al., 2015; Wulandari, et al., 2016; Sunyono, 2015). Research that uses the SiMaYang learning model, show that the SiMaYang learning model can improve concept mastery (Hasanah, et al., 2015; Suryani, et al., 2015; Anwar, et al., 2015; Soleha, et al., 2015), and improve learning outcomes (Fitri, 2016). This study aims to analyze the effectiveness of the SiMaYang type II learning model on Angiosperms material on understanding the macroscopic, microscopic, and symbolic levels.

METHODS

This study used an experimental designs with multiple pretest-posttest group design involving 2 experimental classes. This study population is Mathematics class X SMA Negeri 1 Warureja academic year 2020/2021. Sampling using techniques cluster random sampling produces Mathematics class X MIPA 2 and X MIPA 3 as samples. Class X MIPA 2 is first-class experiment that uses SiMaYang Type II. Class X MIPA 3 is experiment class II were using Discovery Learning. Each class consists of 30 students. The independent variable of this study is the SiMaYang Type II learning model and the dependent variable is understanding the macroscopic, microscopic, and symbolic levels.

The SiMaYang type II learning model has four phases, namely orientation, imajination-exploration, internalization, and evaluation. In the orientation phase, the teacher conveys the learning objectives and provides motivation in the form of event that occur in daily life. The imagination-exploration phase, where the teacher provides visualizations in the form of videos, pictures, simulations, analogies, or demonstrations. Students are free to search for literature, such as books, the internet, practicum, or experiments. Students discuss solving problems in the form of student worksheets. The internalization phase is that students present the results of group work and do individual exercises. In the evaluation phase, the teacher explains what the students have learned. Students work on assignments or questions (Bait, et al. 2018).

The instrument used was a multiple-choice test of Angiosperms material. The instrument was tested for the level of difficulty, distinguishing power, and reliability with the Test Analysis Program (TAP) software. The test results were 34 out of 40 questions that could be used as a research instrument and had a KR20 value of 0.898, which means the questions had high reliability.

The research data were obtained from the pretest and posttest Angiosperms material given to the two experimental classes. From the pretest and posttest score, the N-gain score is obtained. The N-gain score is then sorted according to the level of understanding, namely macroscopic, microscopic, and symbolic. Then each N-gain score of each dependent variable must go through the multivariate normality test and the covariance matrix homogeneity test as Manova's prerequisite test. After the prerequisite test is met, it is followed by the Manova test.

RESULTS AND DISCUSSION

The multivariate normality test and the covariance matrix homogeneity test are prerequisite tests for the Manova hypothesis test. The multivariate normality test and the covariance matrix homogeneity test were performed. The results of the Kolmogorov-Smirnov normality test can be seen in Table 1 below.

Table 1. Normality Test Results

Experiment Class	Level of Understanding	Sig Value.
I (SiMaYang Type II)	Macroscopic	0.200
	Microscopic	0.074
	Symbolic	0.059
II (Discovery Learning)	Macroscopic	0.200
	Microscopic	0.200
	Symbolic	0.200

The six values sig. are greater than 0.05 so it can be interpreted that the six N-gain data are normally distributed. After the normality test, the N-gain value was tested for the homogeneity of the covariance matrix using the Box's M test with the result of the sig value. 0.836 > 0.05, which means that the covariance matrix of the three dependent variables is homogeneous.

Hypothesis testing using Manova in the Test of Between Subjects-Effect section is in Table 2 below.

Table 2. Manova Test Results

Level of Understanding	Sig Value.
Macrocospis	0.010
Microscopic	0.016
Symbolic	0.396

The results of Manova's hypothesis test, understanding the macroscopic level, resulted in a sig. 0.010 <0.05, indicating that there is a significant difference between the SiMaYang type II learning model and Discovery Learning towards understanding the macroscopic level. The results of Manova's hypothesis test, understanding the microscopic level, resulted in a sig. 0.016 <0.05, indicating that there is a significant difference between the SiMaYang type II learning model and Discovery Learning on microscopic level understanding. The result of the Manova hypothesis test, understanding the symbolic level produces sig. 0.396> 0.05. So it can be interpreted that there is no significant difference between the SiMaYang type II learning model and Discovery Learning on understanding the symbolic level.

The difference between the mean N-gain of the SiMaYang type II and Discovery Learning groups can be seen in the following Figure 1.

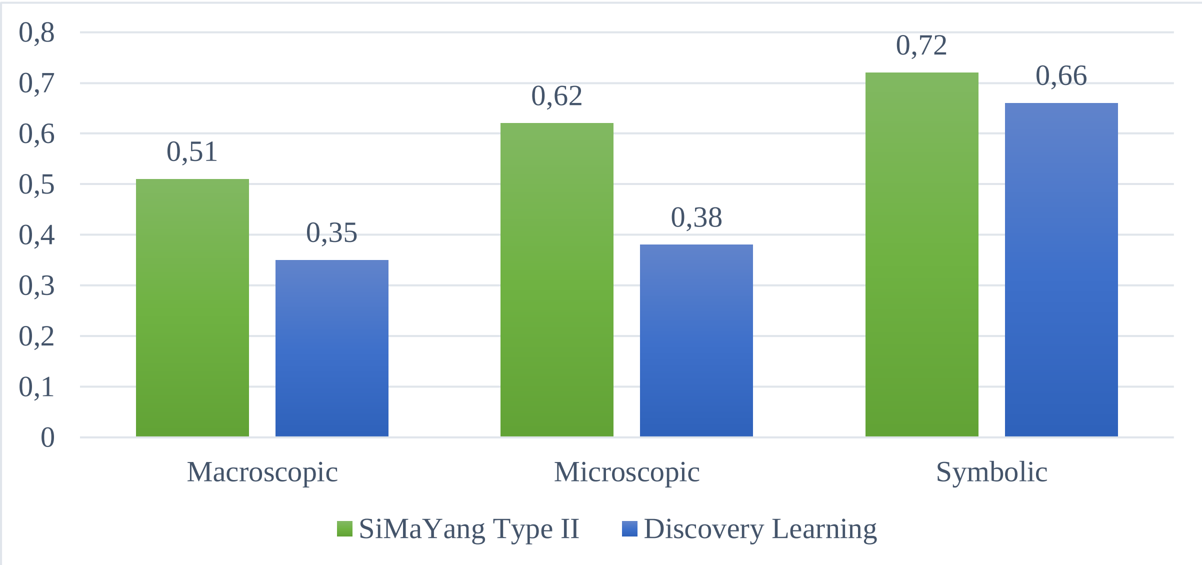

Figure 1. N-gain value of SiMaYang Group Type II and Discovery Learning

The N-gain value of macroscopic understanding obtained by the type II SiMaYang group was 0.51 with moderate criteria. Meanwhile, the N-gain value of the Discovery Learning group was 0.35 with moderate criteria. The mean N-gain of SiMaYang type II class is higher than that of the Discovery Learning class. This means that SiMaYang type II is more effective in increasing understanding at the macroscopic level.

The N-gain value obtained by the SiMaYang type II group is 0.62 with moderate criteria. Meanwhile, the N-gain value of the Discovery Learning group was 0.38 with moderate criteria. The mean N-gain of SiMaYang type II class is higher than that of the Discovery Learning class. This means that SiMaYang type II is more effective in increasing the understanding of microscopic levels.

The N-gain value obtained by the SiMaYang type II group is 0.72 which is the high criterion. Meanwhile, the N-gain value of the Discovery Learning group was 0.66, which was an increase in understanding at the microscopic level at moderate criteria. There is no significant difference between SiMaYang type II and Discovery Learning. It can be seen from the difference between the mean N-gain of the two classes which is not too significant, namely 0.06. Therefore, the interpretation of the results, namely SiMaYang, is not more effective than Discovery Learning in increasing understanding of the symbolic level.

SiMaYang type II can improve the understanding of the macroscopic level in line d e n gan research on Sholihah and Arif (2020), Fitri (2016), and Bait et al. (2018) which states that the SiMaYang type II model can improve understanding of the macroscopic level. This is because, in the syntax of the SiMaYang type II learning model, there are exploration and internalization phases. Phenomena nature at the macroscopic level can be understood through the learning experience or direct observation in both the real objects and pictures.

In the exploration phase, students are given the freedom to search for information both from books and the internet, and discussions. The results of searching for information on the internet are combined with observation. There is an internalization stage, there is an individual exercise that requires students to make direct observations. Observations were made to identify the characteristics of the plants and image objects. This research was conducted during the Covid-19 pandemic, so students study at home. Students use the environment around the house as a learning resource. Observation activities using the environment around the house can improve learning outcomes (Ngabekti et al. 2017; Sari et al., 2012; Firnanda & Santoso, 2019; Kusumawati et al., 2019) and students' understanding of concepts (Afifah et al., 2017). This activity can improve understanding at the macroscopic level. Observation can strengthen students' long-term memory from a macroscopic perspective and create experiences; therefore students gain meaningful knowledge (Susilaningsih et al., 2018; Alighiri et al., 2018).

The Discovery Learning group was given the freedom to use the internet as a learning resource or observe plants around the house. However, they prefer to use the internet as their main learning resource. It can be seen from the results of the discussion answers that they provide in the form of a table of differences in Liliopsida and Magnoliopsida plants. These tables are instantly available on the internet. Information obtained from the internet should be sorted and processed properly, so that good media literacy is needed.

SiMaYang type II is effective for improving understanding at the microscopic level in line with research from Wulandari et al. (2016) and Wati & Iriani (2016) where there is a syntax for the type II SiMaYang learning model, there is an exploration phase accompanied by an imagination phase. Imagination activities are needed for imagining microscopic objects so that they can be transformed into macroscopic.

Students are asked to explain the reproduction process of Angiosperms which is outlined in the form of angiosperms double fertilization scheme and differentiate between Liliopsida and Magnoliopsida plants based on the arrangement of their transport beams. The process of plant reproduction material in the form of abstracts requires media visualization so that the material is understandable for students (Susilaningsih et al., 2016). In the imagination phase, the teacher provides a video of Angiosperms reproduction. Video animation has a good effect on student learning outcomes (Ardianti et al., 2012). Understanding the microscopic level requires the ability to observe microscopic visuals. The microscopic object observed can be in the form of a plant anatomy image. In the internalization phase, students are trained to provide descriptions of cross-sectional images of Liliopsida and Magnoliopsida rods. Image media can stimulate understanding at the microscopic level (Hidayat et al., 2019).

In the imagination-exploration phase of the SiMaYang type II class and the stimulation Discovery Learning phase, students are invited to watch a video demonstration of how to compile the keys of determination and cladograms. Students encouraged to read or recall the material (relearning) that have been studied in previous chapters, namely the classification of living things. Learning to use pictures, videos, and text will provide cognitive benefits in helping remember (Angwin et al., 2019). Then both classes were given the same problem, namely the classification of living things, in particular how to compile a cladogram and the key of determination based on the instructions given. Relearning involves learning information previously studied (Jittibumrungrak and Hongwarittorrn, 2019), thus understanding the symbolic level of both classes experiment showed no significant differences.

In compiling the key of determination and the cladogram, students use the key of determination which is equipped with a picture of a plant. The pictorial determination center makes it easy for students to understand the statements or terms contained in the key of determination. Statements in the form of sentences are reinforced by explanatory images so that students get a more realistic picture of plants. This will make it easier for students to identify plants (Kusumarini, et al., 2012).

In this study, learning was carried out online. Participants students to be free to learn, obtained information available on the web anywhere, and communicate with friends to discuss (Nurhayati & Natasukma, 2019). Searching activities need a lot of information and are also constrained signal problems. During the question and answer time and discussion, students gave a long response. The learning time for 90 minutes for one meeting is not enough, so the teacher needs to provide a response time limit so that the learning time is more efficient.

CONCLUSION

SiMaYang type II is effective in improving understanding at the macroscopic and microscopic level, but not for the symbolic.

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