The plant anatomy practicum uses a smartphone-assisted digital microscope in improving student compound intelligence

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Abstract. The background of this research is that the activity of students at the time of plant anatomy practice is not conducive and the learning process given is not oriented to explore students' multiple intelligence ability, so that the visual, logical-mathematical, physical-kinaesthetic and naturalistic ability of students is still low. This is evidenced through reports of their lab results and their learning activities are still low, but in generally plant anatomy is a window to explore science or science curiosity is not limited. The purpose of this study is to increase student learning activities, improve students' multiple intelligence, and to find out students' responses to the application of digital microscope assisted smartphone in practicum of plant anatomy. Student learning activity is assessed by using observation sheet, the ability of multiple intelligences is measured by using test in the form of description, and student responses were assessed using a response questionnaire. The result of the research shows that the increase of students' learning activity has very good criteria. The use of digital assisted microscope can improve students' intelligence ability, and the student response to the use of digital microscope with the aid of smartphones in the plant anatomy practice has very good criteria.

1. Introduction

Based on the observation that has been done through direct observation in the process of teaching practicum anatomy of plants in one private university in Indramayu district in biology education program, showed low student learning activity and the learning process has not been oriented to exploring the ability of students' multiple intelligence, so that the visual, logical-mathematical, physical-kinaesthetic and naturalistic ability of students is still low. This is evidenced through the reports of their lab results and their learning activities are still low, but in generally plant anatomy is a window to explore science or science curiosity is not limited.

Based on the problem, there needs to be innovation in packing the learning process with effective practicum media. The existing microscope provides low image quality, low image enlargement, impracticality, and cannot be used online. Along with the development of technology and easy availability, can be developed practicum media plant anatomy by modifying a digital microscope equipped smartphone as a picture catcher. The advantages of digital microscopes designed include having a lens enlargement and digital zoom with better image quality, and can be used online. Thus the
laboratory anatomic practice will be more interesting and cultivate science literacy, so that multiple intelligences are explored well.

The advantages of digital microscopes are evidenced by previous researches, virtual microscopy systems increase learning productivity, learning efficiency, critical thinking, ease of communication and student self-confidence [1], because the virtual slide microscope is easy to navigate, and the quality of virtual images is better than a normal microscope [2]. Improving students' understanding through the Handmade Model designed a microscope against an optical microscope by building and testing simple boundaries [3]. The application of Interactive microscope smartphones can facilitate the stimulation of observational observations of microscopic organisms, this smartphone's interactive microscope design incorporates learning elements of microorganisms and games [4]. The epifluorescence microscope can motivate learning and conduct a student scientific investigation [5], because the epifluorescence microscope has several advantages such as a selective microscope (SPIM) light plane lasting several hours to several days [6], consisting of two detection lenses and a lighting purpose, fast in toto fluorescence imaging of biological specimens with subcellular resolution [7], and has a flexible automated design with the ability to facilitate transitions and so on [8].

2. Research methods
This research uses quantitative approach with Quasi-Experimental method, according to Creswell [9] the design used in this research is Quasi-Experimental Design with Randomized Control-Group Pretest-Posttest. The research flow consists of literature study stage, field study, problem formulation, validation problem, pretest, practice of plant anatomy using digital microscope assisted by smartphone, observation of learning activity, pretest, posttest, response to learning, data analysis, research result, and conclusion. This research was conducted in one of universities in Indramayu Regency. The sample in this study was taken by purposive sampling from 2 classes with the number of 40 students. One class is used as an experimental class whereas one other class is used as a control class.

The instruments used in this research are observation sheet, test, and response questionnaire. The data obtained in this study consisted of qualitative data that is the result of student activity observation at the time of lab and questionnaire of student response to the use of digital microscope assisted smartphone, and quantitative data ability of student compound intelligence. Qualitative data were obtained using conceptual analysis format, and descriptive analysis using rubric, while quantitative data were analyzed using inference statistic.

3. Results and discussion
Student learning activities are obtained from observations during the learning process at each meeting by using the observation sheet. Based on the results of these observations, then performed data analysis of student learning activities at the last meeting. The average score and percentage of each aspect of activeness indicators can be seen in table 1.

| Indicator                          | Average Score | %     | Criteria |
|-----------------------------------|---------------|-------|----------|
| Working with a group of friends   | 3.24          | 93.18 | good     |
| Actively ask questions and express opinions | 3.29          | 94.70 | good     |
| Exchanging opinions with other groups | 3.11          | 89.39 | good     |
| Responsible for the task          | 3.26          | 93.94 | good     |
| Be honest when doing the task     | 3.11          | 89.39 | good     |

Based on the results obtained in table 1 shows the overall average score of each indicator of student learning activity after practicum of plant anatomy using digital assisted microscope smartphone has good criteria. The six indicators are student activities that follow the learning activities be it oral, visual, metric, and mental activities [10]. The highest student activity indicator with the average score of 3.29 is actively asking questions and expressing opinions, this happens because the students' curiosity is getting higher when practicing plant anatomy by using digital microscope based on smartphone.
Based on the result of observation obtained in Figure 1 shows that the total score of the students' activity that practicum of plant anatomy using smartphone-assisted digital microscope reach good and very good criterion equal to 94.74%, while the indicator of minimum success in this research is 70% or very good. This shows that practicum of plant anatomy using smartphone-assisted digital microscope can improve student learning activity.

Figure 1. Percentage of student learning activities.

Data of students' multiple intelligence on plant anatomy was obtained from pretest and posttest, analyzed descriptively quantitative. The results of the percentage category score analysis of students' multiple intelligence per indicators can be presented in table 2.

Table 2. Percentage of students' multiple intelligence skills.

| Indicator Code     | Control Average | % Criteria | Experiment Average | % Criteria |
|--------------------|-----------------|------------|--------------------|------------|
| Physical kinetics  | 9.3             | 47 less    | 15.3               | 76.6 good  |
| Logical-mathematical | 10.4           | 52 less    | 14.8               | 74.2 enough |
| Visual-spatial     | 9.8             | 49 less    | 14.9               | 74.61 enough |
| Naturalistic       | 10.2            | 51 less    | 15.1               | 75.66 good |

Based on table 2, all aspects of indicator of students' multiple intelligence ability of control class have less category on each indicator, while in experimental class aspect of kinetetic physical intelligence indicator has average score of 9.3 or 76.6% with good criterion, aspect of indicator of logical-mathematical intelligence has average 10.4 or 74.2% with enough category, aspect of indicator of spatial visual intelligence have average score of 9.8 or 74.61% with enough category, aspect of indicator of naturalistic intelligence has score average 10.2 or 75.66% with good category.

It can be concluded that the improvement of students' multiple intelligence skills in the experimental class is better than the control class. To test the hypothesis of differences in learning activity and multiple students' intelligence abilities using smartphone-assisted digital microscopes on a plant and class anatomical practicum that did not use a digital microscope with the help of smartphones, using independent test samples t test SPSS 20 for windows. Summary of independent samples t test can be seen in table 3.

Table 3. Independent samples t test.

| Researcher Variable | F     | Sig. | t    | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |
|---------------------|-------|------|------|----|-----------------|-----------------|-----------------------|------------------------------------------|
| Levene’s Test       |       |      |      |    |                 |                 |                       |                                          |
| for Equality of     | 22.714| .000 | 11.987| 74 | .000            | 22.800          | 1.902                 | 19.010 - 26.590                        |
| Variances           |       |      |      |    |                 |                 |                       |                                          |
| t-test for Equality of Means | 22.800 | 1.902 | 19.010 - 26.590 | 18.880 - 26.719 |

Equal variances assumed

Equal variances not assumed
Based on the test results in table 3. It appears that \( t \) arithmetic is 11,987 while \( t_{table} \) (0.05; 93) is 1,663, hence can be concluded \( t_{count} \) bigger than \( t_{table} \). This shows that there is a significant difference between using a digital assisted microscope aided by a class using a regular microscope. This suggests that the plant anatomical practicum uses digital-assisted digital microscopes better than using a regular microscope. This happens because the digital microscope is having a lens enlargement and digital zoom of the smartphone so that the image quality is better than using a simple microscope, and also the digital microscope can be used online through social media, so the practice of plant anatomy will be more interesting and stimulating the desire of science-student literacy, so that multiple students’ intelligence will be explored by itself.

Student response data on the use of digital assisted microscope was obtained by using student response questionnaire. The percentage of student responses per indicator is shown in table 4.

| Criteria               | 1 | 2          | 3 | 4          | 5 | 6          | 7 | 8          |
|------------------------|---|------------|---|------------|---|------------|---|------------|
| strongly agree         | 63| 73.68      | 100| 63.16      | 100| 55.3       | 53.9| 0          |
| agree                  | 38| 26.32      | 0 | 34.21      | 0 | 31.6       | 44.7| 100        |
| less agree             | 0 | 0          | 0 | 2.632      | 0 | 10.5       | 1.3 | 0          |
| disagree               | 0 | 0          | 0 | 0          | 0 | 2.6        | 0   | 0          |

Description of Student Response Indicator, (1) response to learning of plant anatomy practice using a digital microscope assisted by smartphone, (2) interest of practicum activity of plant anatomy, (3) benefits of the online practice process, (4) effectiveness of time in learning by using digital microscope assisted smartphone, (5) learning experience, (6) material comprehension, (7) ability of students multiple intelligence, (8) advantages of digital microscopes based on smartphones.

The results showed that in general the students gave a positive response to the practicum of plant anatomy using a smartphone-assisted digital microscope. This is indicated from the data of the number of students who stated strongly agree on each item by 70%, agreed at 28.77%, and less agree by 1.05%. The total score of all response items is 2280, while the highest total score is 2101, which means that the data has very good criteria. These results show that students respond very well to the practicum of plant anatomy using a smartphone-assisted digital microscope, it can be seen in figure 2.

According to the students through a response questionnaire stated that after following the plant anatomical practice using a smartphone-assisted digital microscope, they felt more understanding of the material of plant anatomy, could motivate the spirit of learning, the classroom atmosphere became fun, the time used was sufficient and effective, the concept of plant anatomy became more easily mastered and made them literate and want to continue to explore knowledge through cell and tissue observations on the lab, and explore the potential of their multiple intelligences such as kinesthetic, visual, spatial, mathematical and naturalist visual intelligence.
4. Conclusion
Increased student learning activity after practicum of plant anatomy by using digital assisted microscope has very good criteria and score of each indicator of student learning activity have good criterion, practicum of plant anatomy by using digital assisted microscope can increase student ability of student's multiple intelligence and student response to digital microscope assisted smartphone has very good criteria.

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