EFFECTIVENESS OF SCIENTIFIC EDUCATION PROJECT-BASED STUDENT WORKSHEET

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ABSTRACT

The study with title effectiveness of scientific project-based student worksheet in improving students' cognitive, Affective And Psychomotor Aspects, uses a study design experiment are modified as needed. The scientific project worksheets are based on three more specific models: inquiry, Problem-Based Learning (PBL), and Project-Based Learning (PjBL); each was respectively assigned to physiology, animal ecology and biotechnology subjects. The study involved 60 students of class of 2013-2014, consisting of 30 students of controlled group and 30 students of experimental group. The results show that there are significant differences in terms of cognitive, affective and psychomotor aspects of the groups. Hence, it can be concluded that scientific project-based student worksheets are considered effective in improving students' cognitive, affective and psychomotor aspects via providing them real scientific processes, such as process-oriented investigations of problems, which eventually lead to improvements in terms of the ability to think critically, the development of scientific attitudes, and the ability to build synergistic relationship among involved students in solving problems.

Keywords: Affective, Cognitive, Problem Based Learning, Project Based Learning, Psychomotor.

INTRODUCTION

Changes to teaching and learning processes at schools, namely those of classroom instructions and assessment (Abidin, 2014). Abidin further explained that teaching and learning processes in Curriculum 2013 are geared toward nurturing productive, creative, innovative and affective Indonesian people through strengthening attitudes (knowing why), inquiry (knowing how), and knowledge (knowing what). While in terms of assessment, the competence of attitudes, knowledge and skills should be assessed in a balanced way so it can be used to determine the relative position of each learner against the standards set in the curriculum (Abidin, 2014). The expected result of the processes within the learners is a balance of the competences of being civilized people (soft skills) and the mastery of skills and knowledge to live well (hard skills), which cover the aspects of attitudes, skills and knowledge (Depdiknas, 2013).

According to (Barringer et al., 2010), a scientific process learning is a learning process that requires students to think systematically and critically in an effort to solve problems whose solution is not easily seen. This model requires students to act as a scientist. In practice students are required to perform a series of scientific method steps (Kuhlthau et al., 2007) in (Abidin, 2014; Sailah et al., 2015).
The sequence includes:

1. Formulating the problem.
2. Proposing the hypothesis.
3. Collecting data.
4. Processing and analyzing the data.
5. Drawing conclusions.

However, the data needs assessment that involves students of biology education in one of private teacher training institutions in Bandung shows that their ability of composing and designing scientific-project-based worksheets-which are usually used as guidance in practicums-is still below the standard, with the average score of 1.90 to 2.00. Specifically, there are some inappropriateness in terms of the stages or syntax of scientific inquiries, the practicum procedure, and the content of the practicum. The questionnaires following the study show that one of the causes of the aforementioned phenomena is the lack of exercises and assignments in developing and designing student worksheet (Ibrahim, 2015; Valencia-arias et al., 2018). It suggests that the learning process at the institution has not fully implemented a scientific-based approach. Furthermore, Ibrahim's analysis and comparative test on some guided practicums in the institution show that the module used by its students employed learning stages/syntaxes that are not in line with the demands of Curriculum 2013.

This model can facilitate students to experience complex mental processes such as:

1. Exploring and identifying problems.
2. Formulating hypotheses.
3. Designing and performing hypothesis testing.
4. Conducting experiments.
5. Organizing and analyzing the data obtained.
6. Integrating knowledge.
7. Developing scientific attitudes (being objective, curious, open-minded, passionate and attentive, and responsible) (Sund & Trowbridge, 1981).

Project-based learning is a learning model that directly involves students in the learning process through research activities related to completing certain learning project (Abidin, 2014). In addition, the Project Based Learning learning model based on Student Worksheets is a project-based learning model that can be used to improve student creativity (Sahtoni et al., 2017).

Various studies have shown that scientific-based learning model is very effective in improving students' scientific skills (Fikriyah et al., 2015). Prospective teachers need to be educated about the methods, models or strategies that emphasize the scientific approach especially biology education courses, so as to meet the expected pedagogical competence and become professional teachers in their fields.

RESEARCH METHODOLOGY

This study used educational Research and Development (R&D), which were modified in a few components. The scientific learning model is integrated within student worksheet. Student worksheet is an instructional tool consisting of a series of questions and information designed to guide students to understand complex ideas as they work through it systematically. Moreover,

students can complete it on their own or in discussions with their peers. Each worksheet model was employed in practicums of three different subjects: inquiry-based worksheet in physiology subject practicums, Problem Based Learning (PBL) model in the practicums of animal ecology subject, and project based learningin that of biotechnology subject.

The study involved 60 students of 2013-2014 batch, consisting of 30 students of controlled group and 30 students of experimental group. In this study, the experimental groups were given scientific-based worksheets while the control group were taught using conventional, not specifically scientific-based, worksheets commonly given by the faculty. The effectiveness of the three worksheet is measured from three required-to-develop aspects in Curriculum 2013: cognitive, affective, and psychomotor aspects. The cognitive aspects include the stages or syntaxes involving formulating hypotheses, formulating topics, determining practicum tools, making experimental graphs, and interpreting the data obtained. The psychomotor aspect is measured through performance assessments, those that require learners to demonstrate particular competence through demonstrations, projects and portfolios. It is in accordance with National Education Department's regulation no. 66 of 2013, regarding skill assessment.

The study employed several instruments to collect the data. They are:

1. Written test to assess the participants' cognitive ability.
2. Attitude scale test to assess their scientific attitude/affective aspect.
3. Performance and portfolio assessment to assess their psychomotor ability.
4. Questionnaires to gather their responses on the use of the worksheets.
5. Lecturer interview guidelines.

The data collected were qualitative and quantitative in nature. To ease the data analysis, the qualitative data from affective and psychomotor aspects assessment were converted into quantitative data. Both sets of data were then analyzed statistically using SPSS-20 software, which then were interpreted.

Measurement of cognitive abilities and development of research students has standards. Standard instruments in theory are used from theory and have empirical standards of relevant student tasks and activities and adequate representation. Some standards for calculating students based consist of various standards, and measuring student ability. The standard is a reference in measuring student ability. In addition, measuring cognitive abilities also reflects objective and instructional positions based on taxonomic tables. There are four attitude abilities possessed by students that are measured general beliefs about distance education, confidence in prerequisite skills, self-direction and initiative, and desire for interaction. Portfolio assessment that comes from student assignments consists of despite variations in content and format, portfolios basically report on work done, feedback received, progress made, and plans for improving competence. The worksheet questionnaire consists of a guide for the lecture is to work in groups, interacting with colleagues to manipulate various objects, asking questions, focusing on observation, collecting data and attempts to explain natural phenomena. Some guidelines for questions that were raised in the lecture, namely sample questions consist of how students learn collaboratively, how students learn interestingly, how to use collaborative learning, how to assess collaborative learning (Table 1).

Table 1
INSTRUMENTS OF COLLECT DATA

No	Measured Instruments	Assessment Indicator
1	Cognitive Ability	Measuring cognitive abilities also reflects objective and instructional positions based on taxonomic tables (Paidi et al., 2017).
2	Attitude Scale Test	distance education, confidence in prerequisite skills, self-direction and initiative, and desire for interaction (Kisanga & Ireson, 2016).
3	Performance and Portfolio Assesment	Despite variations in content and format, portfolios basically report on work done, feedback received, progress made, and plans for improving competence (Driessen et al., 2003).
4	Questionnare Responses	colleagues to manipulate various objects, asking questions, focusing on observation, collecting data and attempts to explain natural phenomena (Satterthwait, 2010).
5	Lecture Interview Guidelines	how students learn collaboratively, how students learn interestingly, how to use collaborative learning, how to assess collaborative learning (Pathak & Intratat, 2012).

Both of quantitative data sets were then analyzed by statistically descriptive using the SPSS tool version 20an IBM software (Hejase & Hejase, 2013).Every aspect of curriculum such cognitive, affective and psychomotor ability of students will be assessed based on both scientific-based learning model and traditional model. The scientific-based learning model consists of inquiry, PBL and PjBL model. Both result controlled group and experimental group then compared in each score and total mean score to see how effectively the models. The measurement of cognitive aspect includes many aspects such as conducting investigation, identifying problems, looking for references, proposing solutions until generating the conclusion. The affective aspects include curiosity, honesty, objectivity, discipline, critical thinking, responsibility, cooperation, confidence, persistence, tolerance, motivation and care for the environment. The measurement of psychomotor aspects involves planning, implementation, project reporting, presentation and exhibition stages.

RESULTS AND DISCUSSION

This section elaborates the data collected from the implementation of the scientific-based learning model in the form of inquiry, PBL and PjBL student worksheets, which were integrated in Animal Physiology, Animal Ecology and Biotechnology subjects.

Analysis of the Participants' Cognitive Ability

The following Figure 1 describes the data obtained from assessment on the participants' cognitive aspect as follows.

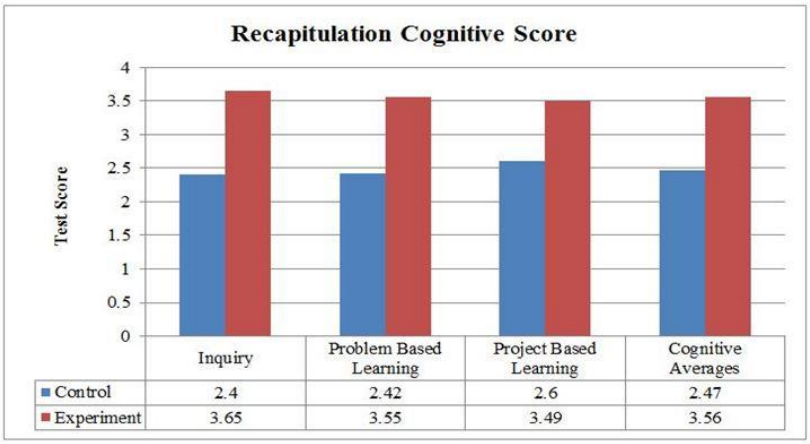

FIGURE 1
RECAPITULATION OF PARTICIPANTS' COGNITIVE ASPECT AVERAGE SCORE

The comparison of the average scores of both the experimental and the control group shows a significant difference of mean. To determine the significance of the difference, the data were analyzed through statistical test. The recapitulation of the calculation results is compiled in Table 2 below.

Table 2
COGNITIVE ASPECT TEST

Class	Normality Test		Average Comparison Test		Anova Advanced Test	
	Taraf Significance	Conclusion	Taraf Significance	Conclusion	Significance Level	Conclusion
Inquiry Control	0.032	Abnormal	0.000	There is a difference of cognitive test mean	0.000	Significant
Inquiry Experiments	0.055	Abnormal			0.061	Significant
PBL Control	0.005	Abnormal			0.000	Significant
PBL Experiment	0.023	Abnormal			0.000	Significant
PjBL Control	0.006	Abnormal			0.000	Significant
PjBL Experiment	0.065	Abnormal			0.000	Significant

The result of the statistical test shows that the implementation of the scientific-based worksheets on lab activities is effective in improving the cognitive aspect of students rather than using conventional worksheets. This can be seen from the difference in the experiment group's average score of concept comprehension, which is better than that of the control group. It also indicates that the worksheets models are proven better in providing concept comprehension and higher rate of knowledge retention. The learning stages or syntaxes of the worksheet model have positive effects on improving student concept mastery. It is due to the participants' involvements in solving the problems. The participants were required to conduct investigations, look for sources and related references in regard to the problems encountered, not only in the field but also during lab activities in the laboratory. They were also required to identify the problems and their formulating questions to find the solutions. When having practicum, they had discussions with their peers. It suggests that the scientific learning process also encourages students to solve problems through careful planning, data collection and data analysis to produce a conclusion.

Students' ability to formulate hypotheses also shows students' ability to focus more on solving problems faced and completing projects. The ability to formulate hypotheses requires

students to develop their reasoning skill so as to formulate a temporary answer to the question posed. Through this reasoning activity students will be accustomed to critical thinking, to be reflective and creative (Abidin, 2014). The stages that the participants identify in formulating the title/topic of problems given in the experiments are appropriate to find the solutions. The experimental group students have started to focus on one problem as seen in the PBL worksheet model, which enabled them to focus on conducting mini research, a small step but has a big impact on the development of student thinking as it leads to higher order thinking skills. The results of the analysis are supported with the ability of students to provide solutions both ideas and real solutions related to problems they faced the field. At the stage of selecting tools and materials to be used to solve given problems, the participants were more focused on the tools and materials that would be utilized in the practicum. The participants' ability in determining steps of inquiry is seen in their approach in solving the problem through systematic procedure, data collecting, and ability in interpreting data and suggesting solutions. (Creswell, 2012) argued that one of the objectives of research is to improve one's understanding, knowledge and scientific concept. Some research shows the application of scientific method in learning has been able to increase students' understanding of the material as well as to strengthen student retention on the material being studied (Shabiralyani et al., 2015). The students' cognitive achievement in interpreting the observation result in the form of observation table which became the basis of the students' analysis and synthesis ability improved very well.

The controlled group participants' ability in making graph is seen from their ability to make graph relevant to findings in their practicum and to relate facts and data in field with previous research and existing theories. This activity is seen as the students are able to elaborate the result of the analysis that has been produced. The cognitive achievement of the students in summing up the overall performance becomes an indicator of the ability of students to associate the concept with facts and theories. The participants' ability in concluding a practicum requires students to be able to interpret the data properly and accurately in accordance with the facts obtained. In this activity the participants were demanded to sum up the results of their practicums. In that they are expected to be able to generate the conclusions from it.

According to (Abidin, 2014) interpretation activities are activities that students do to interpret the results of simple research that has been done. Should be in the research, at the time of interpretation of data students can use textbooks or existing theories so that students are skilled in creating a network that connects the results of research with existing theory (Abidin, 2014). In conclusion, the scientific-based worksheets are proven helpful to improve participants' cognitive aspects, particularly in relating relevant facts with supporting theories which eventually contributes to their thinking and reasoning skills.

Analysis of Participants' Affective Aspect (Scientific Attitudes)

Based on the questionnaires given to assess the difference of affective aspect of the control and the experimental group, the following data in Figure 2 is acquired. As it can be seen in the chart, the control group's average scores of affective aspect are relatively higher than those of experimental group.

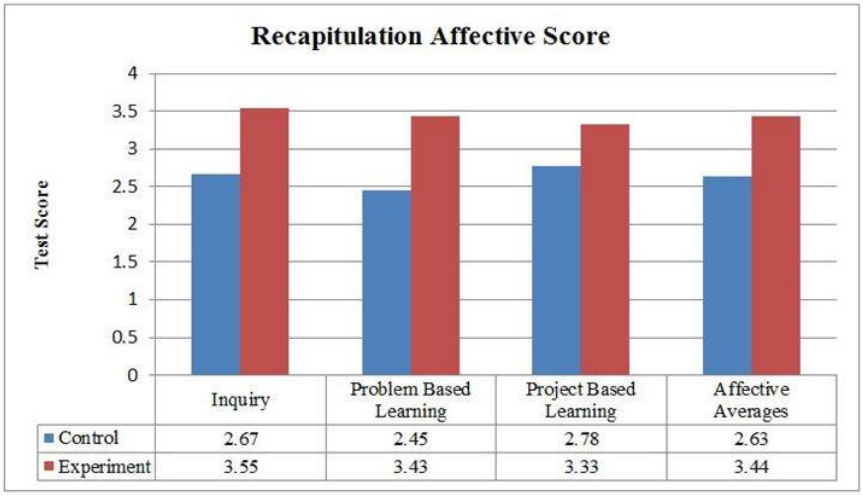

FIGURE 2
RECAPITULATION OF SCORE COMPARISON AVERAGE AFFECTIVE

Assessment results on student affective attitudes or aspect were analyzed using statistical test. The results are shown in Table 3 as follows.

Table 3
AFFECTIVE ASPECT TEST

Class	Normality Test		Average Comparison Test		Anova Advanced Test	
	Taraf Significance	Conclusion	Taraf Significance	Conclusion	Significance Level	Conclusion
Inquiry Control	0.001	Abnormal	0.000	There is a difference of cognitive test mean	0.000	Significant
Inquiry Experiments	0.263	Abnormal			0.000	Significant
PBL Control	0.399	Abnormal			0.000	Significant
PBL Experiment	0.399	Abnormal			0.000	Significant
PjBL Control	0.938	Abnormal			0.000	Significant
PjBL Experiment	0.001	Abnormal			0.000	Significant

The average score of attitude or affective aspect of the experimental group (3.44) is very good compared to that of control group (2.63). Based on the statistical significance test with the significance level of 0.05 shows the difference is significant. The significant difference is an indicator that the scientific-project-based worksheet models significantly influence the participants' attitude improvement towards science.

The attitude shown by the members of experimental groups are increases of curiosity, honesty, objectivity, discipline, critical thinking, responsibility, cooperation, confidence, persistence, tolerance, motivation and care for the environment. These findings indicate that involving students with scientific projects can foster positive attitudes required to develop them to become good researchers. It is due to the scientific project-based approach guides the students to follow systematic and logical scientific stages.

Description of the Participants' Psychomotor Ability

The participants' psychomotor ability involves the ability to plan a research, starting from preparation, topic determining, hypothesis formulation, variable observation, treatment plan,

research procedure, until project preparation and scheduling. The observation on the experimental group participants is greatly improved this is due LKS stages and project tasks require students to undertake the preparation process.

The result of observation on the participants' psychomotor aspect of the students of the control and the experimental groups is shown in Figure 3 as follows.

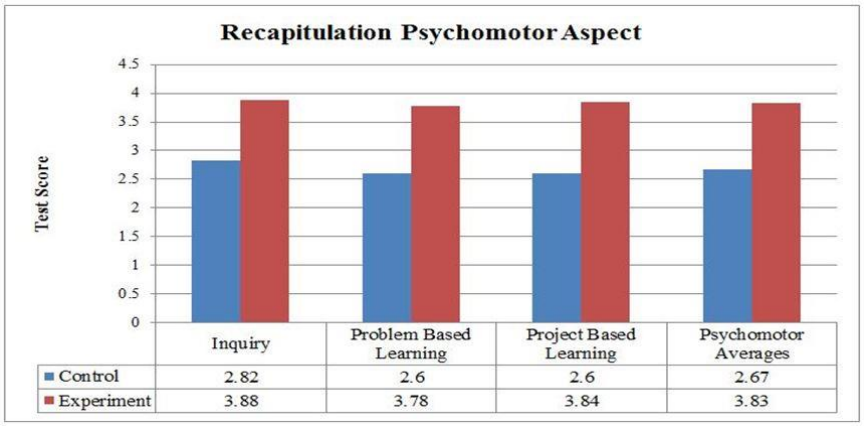

FIGURE 3
RECAPITULATION COMPARISON SCORE AVERAGE PSYCHOMOTOR

As seen in the figure 3, the differences between the average scores of psychomotor ability of the groups is relatively significant, with the experimental group's is higher than those of the control group. The experimental group's means is showing higher means than those of the control has an average of 3.83, categorized as very good/very high while control class with average value of 2.67 indicates good/high category. The following Table 4 shows the results of statistical test on the significance of the averages score difference.

Table 4
PSYCHOMOTOR ASPECT TEST

Class	Normality Test		Homogenity Test		Anova Advanced Test	
	Taraf Significance	Conclusion	Taraf Significance	Conclusion	Significance Level	Conclusion
Inquiry Control	0.155	Abnormal	0.343	Homogeneous	0.000	Significant
Inquiry Experiments	0.487	Abnormal			0.000	Significant
PBL Control	0.321	Abnormal			0.000	Significant
PBL Experiment	0.167	Abnormal			0.000	Significant
PjBL Control	0.785	Abnormal			0.000	Significant
PjBL Experiment	0.136	Abnormal			0.000	Significant

Based on the significance test with the significance level at 0.05, it can be seen that the groups' average score difference is significant. The experimental class demonstrates very high psychomotor abilities starting from the planning, implementation, project reporting, presentation and exhibition stages. The participants' psychomotor ability were assessed in the form of portfolio, which requires students to make project report. This is evident from the systematic assessment of writing, systematic steps and project procedures, the accuracy of data and information sources, quantity of data sources, data analysis, project reporting, conclusions and

presentation of project results. Furthermore, the students were able to develop their work in creative and innovative ways.

The assessment of the aspect also covers the presentation of the project, the students' cooperation in the presentation, and the important points they present in the presentation, the students' comprehension of the nature and scope of the problem in the project, the arguments on particular aspects, responsiveness (whether the presenter answers according to the question asked by the questioner), group collaboration (most group members participate in the presentation). The participants from experimental group shows better performance compared to their control group counterparts. The final assessment of the project in the form of project exhibition.

This finding is consistent with (Fikriyah et al., 2015) who state that there is significant difference in learning result between students learning via project-based model and those learning through direct learning model. Student worksheets based on project based learning models can significantly improve the quality of communication between students. In addition, project-based learning can also help improve student skills. It is also supported by Sari et al. (2017), in which allows people who need to learn in developing skills, because in the learning students can be given to work together, share ideas, create and conduct management in the time needed (Miftari, 2014; Baser et al., 2017; Hope & Allen, 2009; Whatley, 2012).

CONCLUSIONS

The study shows that overall scientific-project-based student worksheets are assessed to be more effective in improving students' cognitive, affective, and psychomotor aspects compared to conventional learning approach. Considering the benefits scientific learning approach offers, teachers are highly recommended to implement it in their classroom. Accordingly, there is a need to conduct further research, particularly in implementing scientific learning approach in other medium of teaching other than student worksheet and in other field, for example language teaching or social science.

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