Learning Experience of Pre-Service Physics Teachers in Developing Simple Project Loaded by Life Skills

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LEARNING EXPERIENCE OF PRE-SERVICE PHYSICS TEACHERS IN DEVELOPING SIMPLE PROJECT LOADED BY LIFE SKILLS

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ABSTRACT

This research aims to reveal the experience profile of future Physics teachers in developing simple multi-loaded life skill project. The research method used was a descriptive method with 62 future Physics teachers as the research subject. Based on observations, interviews, and questionnaires, it was drawn descriptions of the future teachers' experiences in developing a simple project. The future teachers were assessed based on some Physics indicators such as project design, project creation, data collection, data analysis, and creativity. The results of the project preparation descriptions obtained by the experience data of future Physics teachers indicate the highest score of 4.8 (96%) on the indicator of schedule making, while the lowest score was 2.9 (58%) on the indicators of formulating the product benefits, preparing the feasibility analysis and analyzing the environmental impact. The results show that future Physics teachers got the highest score of 4.6 (93%) on data adjustment for experimental purposes indicator, and the lowest score of 2.8 (55%) on designing tools and materials indicator. Based on the Physics props trial, it was obtained the highest score of 4.5 (89%) on the indicator of analyzing the baseline data, while the lowest score of 2.9 (58%) was on the variation test variables. Positive feedback about time-management in completing the project, the ability to identify the topic of the project, the ability to find ideas to support the completion of the project, the ability to test the tools, and the ability to make progress reports on project completion were derived from the interviews. The highest score of students' responses to project completion was 4.8 (95%) on the second data collection indicator and the lowest was 3.2 (64%) on the instrument material design indicator.

Keywords: Simple Projects, Multi life skills.

INTRODUCTION

The academic competence of pre-service Physics teachers has been categorized as 'good' based on knowledge aspect. This can be observed in basic Physics practices for basic concepts of mechanics, fluids, and electricity in the academic year 2013/2014 until 2015/2016. It turned out that during the practicums, future Physics teachers were not able to connect, explore and construct the mastery of concepts as a learning experience during the lectures. In fact, these abilities are needed to support prospective Physics teachers to be professionals (Adams & Wieman, 2015; Docktor & Mestre, 2014; Estella, 2016).

The quality of future teachers includes the concept mastery that cannot be separated from the learning process they experienced (Ceberio, et al., 2016; Haji & Safitri, 2015; Khaeroningtyas, et al., 2016). Physics learning for future teachers

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should meet the following characteristics: (1) future teachers should be prepared to teach at the school level; (2) concrete experiences serve as the foundation for teaching specific concepts; (3) the learning process should begin with an Open-ended research in the laboratory; (4) learning should be designed to help future teachers think critically about the materials they are studying; (5) teaching materials for prospective teachers should be directed to build awareness of the conceptual difficulties that students may encounter later (Putra, et al., 2016; Sumarni, et al., 2016; Supriyanti, et al., 2015).

Basic Physics mastery is essential for future teachers. However, the conceptual learning model that begins with direct involvement through researches in laboratories is not popularly applied. There is no attempt to engage students in identifying and resolving misunderstandings that students might have. Moreover, it is uncommon to present Physics in order to achieve Physics competence as the main objective.

Providing knowledge and skills for future teachers will broaden their mind and develop learning awareness, resulting in students' eagerness to learn. This indicates that future teachers should practice cultivating students' creativity in conducting scientific activities so that the learning and evaluation process will be effective, efficient, challenging, and motivational (Cibik & Yalcin, 2011; Ozdamli, 2011; Nazila & Reza, 2011; Turk, et al., 2015; Hande, et al., 2015). Hence, teachers should adopt various methods, strategies, and models of learning so that learning becomes more interesting. One of the teaching methods that can be used is the project-based method.

The project-based method gives students the opportunity to manage their own problems. This kind of method can be done in 4 stages namely the stage of planning, implementing, assessing and revising. These stages are done by students to complete the project tasks. Project tasks provide a fun and challenging experience for students, help them to increase their experience, knowledge, and creativity. In implementing a project, students should be able to cooperate with friends, help each other and complement each other to complete the task. These would train students' social relationships and solidarity.

Project assignment results can be observed directly and enable students to communicate scientifically the task completion process. This project-based method fosters students' curiosity to learn more and make them be more creative. The learning steps using the project method include (1) exploration, by addressing a simple question, providing a brief explanation and a small illustration to measure students' knowledge on the optical instrument; (2) presentation that explains the content of the materials in the learning process; (3) assimilation, by providing information or facts to fill an urgent subject. This challenges students to find sources that present facts and information related to project completion; (4) collecting data, facts, and information by classifying data, processing data and drawing conclusions. The ability to think and analyze the data is very important at this stage; and (5) assignment in the form of a presentation about students' findings, either verbally or in writing. This stage trains students to review the subject matter by applying the knowledge and experience possessed by them. (Yerushalmi, 2014; Yu, Fan & Lin, 2015; Balliet, et al., 2015).

Special-skill teachers are required in implementing project-based method regarding the detailed project method, operational standard of the procedures, and teaching materials. The use of project-based method in Physics learning takes a long time involving students either individually or classically. The assignments are given gradually, starting from the easiest. The project assignment results are monitored continuously. The holistic analysis method is used to evaluate the project results. While the project itself is conducted starting from collecting information and integrating it with new information, students' experiences and students' real activities. Project-based learning requires a comprehensive learning approach. The assignments in the project-based method are designed for students to investigate authentic problems which deepen students' comprehension on a subject topic and help them perform other meaningful tasks.

This approach introduces students to work independently in constructing products. In project-based learning, students are not only given recitation or complex but realistic projects, but also adequate assistance in order to complete the task. In addition, the implementation of this method encourages students' creativity, independence, responsibility, critical and analytical thinking. Project-based learning is inspired by constructivist learning theory. This theory builds on students' own knowledge in real-life experience. In terms of technology, project-based learning can be viewed as a learning approach that is close to the learning environment, which encourages teachers to construct knowledge and skills through direct experience.

Projects in project-based learning build on teachers' ideas as an alternative form of solving specific, real problems. This suggests that project-based learning has the potential to deepen conceptual and procedural knowledge. Teachers direct the project and control students' ideas and interpretations in learning, learn how to conduct and express arguments on the projects. The characteristics of project-based learning have the potential to provide a more engaging and meaningful learning experience. The purpose of this research is to get the experience of Physics prospective teachers in developing a simple project in the form of Physics props. The results of this study outline the steps taken by prospective Physics teachers, starting from the project planning stage, project implementation, product testing, and project evaluation. These stages are divided into five indicators of Physics prospective teacher skills, among others; designing a project, creating a project, performing data analysis and bringing about creativity. In addition, the results of this study provide a description of learning resources used by future Physics teachers to develop a simple project.

METHODS

This research involved future teachers to design a simple project that produces Physics props for high school level. The developed simple project deals with the concepts of mechanics, fluids, optics, and electricity. Purposive random sampling was used in selecting research samples. The total samples were 62 future Physics teacher of the 2016-2017 academic year at Universitas PGRI Semarang. There were 15 males and 47 females. The samples were divided into 2 large groups. Group 1 consisted of 7 small groups and group 2 consisted of 8 small groups. Each small group consisted of four to five people who have their respective duties.

The data collection tools used were observation sheets and questionnaires. The observation sheets included 4 stages; observation, planning, project implementation, testing, and evaluation. Each observation step consisted of 10 items of observation (Fraenkel & Wallen, 1993). The observation sheets used a 5-point Likert scale with 5 indicators from a positive statement to a negative statement. Interviews were conducted to know the progress of students' projects; the interviews were done in 6 stages according to the students' progress report. Questionnaires were given to get feedback about experiences they have gained in developing simple projects and in using learning resources. Questionnaires were given on product testing activities. The questionnaire consisted of 10 statement items filled by 62 prospective Physics teachers for 20 minutes.

The obtained data were analyzed to give description and interpretation using data tabulation. Observational data were analyzed using independent t-test techniques. The results of the interviews employed the descriptive qualitative analysis. Questionnaire results were analyzed descriptively, while the percentage of students' positive answers was quantitatively calculated to get the maximum score.

RESULTS AND DISCUSSION

The simple project development produced 15 packages of Physics props. The development achieved 70% and 30% improvement, which were obtained after repeated trials. The improvement rate was only 8% on the first attempt without repetition. The Physics props products are harmonic oscillation, automatic heat-conductivity gauge, collision displays, light diffraction, Conductivity Devices, Skewed Fields, Scale board of magnetic field, Refraction index tools, Conduction props, Measuring board, Fluid viscosity, BLDC motor, and Atwood plane.

Project-based learning has preparatory, implementation and evaluation activities. Therefore, the future teachers should design or create a project framework that is useful in providing the information and resources needed by the students in relation to the existing project. This supported the success of the project, helped students answering questions, activities, and completing their work. In addition, Future Physics teachers should perform their role well in analyzing and integrating learning materials. The results of the observations at the planning stage can be seen in table 1.

Table 1. Observation Results at the Planning Stage

Description of the Preparation	Min.	Max.	Mean	%	Std. Dev
Preparing project design	1	5	3.9	78	0.35
Formulating product benefits	1	5	2.9	58	0.27

Preparing a feasibility analysis	1	5	2.9	57	0.40
Creating an activity schedule	1	5	4.8	96	0.56
Preparing budget estimation	1	5	4.0	79	0.30
Arranging stages of the activity	1	5	4.9	97	0.45
Analyzing environmental impacts	1	5	2.9	58	0.30
Planning tools and materials	1	5	4.0	79	0.30
Planning the division of labor	1	5	4.0	79	0.30
Analyzing usage needs	1	5	3.9	79	0.40

The table shows that the highest score was on the indicator of creating the activity schedule and the lowest scores were on the indicators of formulating the benefits of the product, preparing the feasibility of the analysis and analyzing the environmental impact. The results of observations at the implementation stage can be seen in table 2.

Table 2. Observation Results at the Implementation Stage

Description of the Preparation	Min.	Max.	Mean	%	Std. Dev
Collection of tools and materials	1	5	3.9	78	0.4
Tools and materials design	1	5	2.8	55	0.4
Props Design	1	5	3.2	63	0.36
Props Design Variations	1	5	4.6	92	0.8
Initial data retrieval	1	5	3.9	79	0.56
Data adjustment for experimental purposes	1	5	4.6	93	0.54
Initial data analysis	1	5	3.3	66	0.73
Obtained data with other variations	1	5	4.0	80	0.63
Customization of data variations with experiment objectives	1	5	4.1	82	0.65
Analysis of data variations	1	5	4.0	80	0.50

The above table shows the project description obtained by the experience data of future Physics teachers with the highest score on the data adjustment for experimental purposes, and the lowest score on tools and materials design. The results of the observations in the test phase and evaluation of props can be seen in table 3.

Table 3. Observation Results at the Testing & Evaluation Stage

Description of the Preparation	Min.	Max.	Mean	%	Std. Dev
Preliminary data retrieval test	1	5	3.7	75	0.43
Trial variation variables	1	5	2.9	58	0.30
Testing of repeated data retrieval	1	5	3.1	61	0.25
Accurate measurements	1	5	4.4	87	0.93
Proof of experimental purpose	1	5	3.7	73	0.47

Results of initial data analysis	1	5	4.5	89	0.80
Results of variable measurement variation analysis	1	5	3.3	65	0.73
Results of repeated data analysis	1	5	3.7	73	0.54
Easy test tool	1	5	3.7	75	0.62
Recommended appliance repair	1	5	3.8	76	0.48

The results of experimental Physics test obtained by the experience data of future Physics teachers show the highest score on the indicator of analyzing the initial data, and the lowest score on the indicator of variable measurement variation analysis. The results of interviewing the project completion process can be seen in table 4.

Table 4. Interview Results for the Project Completion Process

Description	Statement
Ability to manage time to complete the project	We developed project schedules and set performance targets
Ability to identify project topics	We identified more than two submission project topics
Ability to find ideas to support the project	We found ideas as a test phase to support the completion of the project
Ability to test the tools	We did a test tool to get relevant data to the theory
Ability to make progress report on project completion	We made the progress report of project completion as a reference of improvement

The above table shows the interview results of the students on the project completion process. While the results of questionnaire responses of future Physics teacher to the project completion can be seen in table 5.

Table 5. Responses of Future Physics Teachers to the Project Completion

Description of the Preparation	Min.	Max.	Mean	%	Dev. Std.
The use of tools and materials	1	5	4.1	83	0.5
Designing tools and materials	1	5	3.2	64	0.8
Modification of props design	1	5	3.3	66	0.7
The first data retrieval analysis of the first data	1	5	4.6	92	0.8
The first data	1	5	3.9	79	0.6
The second data retrieval	1	5	4.8	95	0.6
Analysis of the second data	1	5	3.4	68	0.8
Creating charts from tabular data	1	5	3.9	78	0.6
Evaluation of tool making and data retrieval	1	5	4.1	82	0.7
Revision of props	1	5	4.4	82	0.5

The results of the students' responses to the project completion indicated the highest score on the second data collection indicator and the lowest score on the designing tools and materials indicator. Future Physics teachers worked on one individual project and one group project activity in the classroom. They determined the activities and steps to be taken in accordance with the subtopic, planned the time allotment of all sub-topics and saved it. While working in groups, each member has the responsibility to follow the rules. Investigations can be in the form of questioning the experts through e-mail, internet browsing, sharing experience and knowledge, and conducting surveys. In its development, project completion steps include observation, experiment, practice, discussion, and field trips (Usmeldi, 2015; Xiaolai & Qinghuai, 2011).

Students can present their findings through images, writing, graphics, symbols, mapping, and others. Prospective teachers can monitor their progress and presentations via chat. They created reports, presentations, web pages, images, and more. As a result of its activities, the progress of the project reported by future teachers was summarized into project progress notes for further development (Usmeldi, 2016; Riantoni, et al., 2017; Saifullah, et al., 2017). Each future teacher received feedback on what he or she made in groups, friends, and colleagues. Online feedback facility was presented to enable individuals to directly comment and contribute to others.

Monitoring and evaluation are assessed through all project processes done by each learner based on their participation and productivity. Project-based learning or assignment is a method of presenting the provided learning materials through a set of tasks that must be done either individually or in groups. The use of project methods also determines the effectiveness and efficiency of learning and provides opportunities for future teachers to conduct their own learning activities and make assignments to their students later.

Based on the project results, there are several principles that can help students become effective independent learners. First, making the tasks meaningful, clear, and challenging, one of the most difficult challenges faced is keeping all group members engaged. While doing an independent activity, it is very easy for students to lose interest and do irrelevant actions, especially if the tasks are routine. Students need to know exactly what they need to do, why they do the job, and what it takes to get the job done. The students remain on task during classwork and complete homework if they address the tasks significantly.

In the monitoring stage, future teachers should emphasis on procedural directives. Instructions must cover the explanation about what to do, why, and how something should be done. Before assigning a task, teachers should consider the essential characteristics of the task and then make time to explain the important characteristics to the students. Establishing the appropriate difficulty level of the tasks assigned to the student is the ongoing engagement required to complete the tasks. If students are expected to work independently, the task should have a fair difficulty that ensures their success. Students will not be challenged when the tasks are too easy. They will address such tasks as unrelenting jobs. In general, a good task needs to have fair difficulty level so most students see it as a challenging, but doable task. It is important for teachers to monitor students to see if they understand their assignment and the cognitive processes involved (Gani, et al., 2017).

This monitoring also includes checking students' work and returning tasks with feedback. By the time some students are given a class job, the teacher can work with other students. Teachers are encouraged to take 5 or 10 minutes to get around guiding students to see if they understand the task. When students work in groups, then teachers should be in groups in turns and traveling among students working independently. While grading the time-consuming task, teachers should correct students' work and return them with feedback so that students know the shortcomings of their work. Competencies developed in students include discipline-based, interpersonal and intrapersonal competence.

The discipline-based competence focuses on the understanding of the concepts, principles, and theories. Interpersonal competence includes the ability to communicate, collaborate, behave politely, resolve conflict, cooperate, assist others, and establish relationships with other people and society. Intrapersonal competence includes an appreciation of diversity, self-reflection, discipline, high work ethic, healthy self-esteem, emotional control, diligence, independence, and motivation (Docktor & Mestre, 2014; Huang, et al., 2015; Niss, 2017; Baran & Sozbilir, 2017).

Competencies that students gained during the lesson are very important for their success. The nature of project-based learning is collaborative. In groups, the individual strengths and learning styles contribute to the success of the team. The task could motivate, improve problem-solving skills, enhance collaboration, and cultivate resource-management skills.

Many sources describe project-based learning as a method to make students actively involved in solving complex problems. The importance of group working is to develop and practice communication skills. A cooperative group, student evaluation, and online information exchange are the collaborative aspects this method. However, the problems are might be too difficult. That's why teachers should cleverly modify the task so that the difficulty is just at a fair level. Moreover, the implementation of the method might take longer time, spend money, and need a lot of preparation. To overcome the weaknesses of project-based learning, teachers should continuously check students' progress and remind them to finish the project on time, minimizing and providing simple equipment available in the surrounding environment, and selecting an affordable research location that does not cost much.

CONCLUSION

The research product was 13 items of props namely harmonic oscillation, auto calorific power measuring instrument, impact props, diffraction grating, simple electric circuit, incline, scale board of magnetic field, refractive index tool, conductive props, business measuring board, Fluid viscosity, BLDC motor, and ad wood aircraft. The results of observations obtained from the project preparation descriptions show the experience of future Physics teacher achieved the highest score on making the schedule and the lowest scores on formulating product benefits, developing feasibility analysis and analyzing environmental impacts. Based on the Physics props trial, it was obtained the highest score on the indicator of analyzing the baseline data, while the lowest score was on the variation test variables. Positive feedback about time-management in completing the project, the ability to identify the topic of the project, the ability to find ideas to support the completion of the project, the ability to test the tools, and the ability to make progress reports on project completion was derived from the interviews. The highest score of students' responses to project completion was on the second data collection indicator and the lowest was the instrument material design indicator.

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