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Reconstruction of Environmental Physics Learning by Integrating Ethno-technology to Actualize Superior Teacher Candidates

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***Abstract*--The purpose of this research is to reconstruct the learning of environmental physics by integrating ethno-technology to actualize superior teacher candidates. This mix method was held at the physics education study program of Universitas PGRI Semarang. In the preliminary stage is the need analysis, literature study and case study of brick-making process, tile and earthenware by the community around Semarang. The results of the study were used to develop an ethno-technology integrated learning model (EILM) and its device. EILM is applied to enhance the competence of superior teacher candidates, critical thinking skills, problem solving, scientific communication, working in teams, and mastering the information technology and the objective and caring attitudes of the environment. The results of EILM implementation showed that all indicators experienced an increase of N-gain both individually and in the group of achievements. It's mean that EILM can foster the superior of teacher candidates.**

Keywords: Ethnotechnology, teacher education, EILM, critical thinking.

I. INTRODUCTION

The Physics Education Study Program of Universitas PGRI Semarang has a vision to become a study program that is superior and has an identity in the development of physics and education at the National level in 2025. One of its missions is to provide education and exemplary to produce prospective physics teachers who are superior and have identity. The expected profile of prospective physics teachers is educators, creative, innovative learning facilitators who educate with good mastery of physics material, have insight into local wisdom in learning physics, have the ability to use information technology to follow the development of physics and learning, have Pancasila spirit, are supported by English language skills, have a leadership spirit, and have the potential to continue to professional education so that they become professional teachers and are able to continue to higher education levels in both the fields of education and physics[1].

In general, the conditions of learning in private universities are still diverse. Based on the results of research conducted by the Higher Education Curriculum Development Team, the Directorate of Higher Education throughout Private Higher Education Coordinator (***Kopertis***) found that lecturers do not prepare learning tools before doing learning so that lectures are dominated by monotonous lectures and or discussions. Lecturers do not clearly formulate learning outcomes so that lectures are limited to meeting the number of face-to-face lectures [2]. This fact also happened to the Universitas PGRI Semarang, especially the Physics Education Study Program. Based on the report of the 2017/2018 Odd Semester quality assurance sub unit found that 21% of lecturers did not upload Semester Learning Plans (SLP) into the Lecture Information System (sip.upgris.ac.id), and from 79% of the lecturers it is known that 43% did not write the complete RPS. From the data above, it can be concluded that there are still lecturers who do not prepare learning tools properly. Based on observations of the odd semester of 2017/2018, learning in the Environmental Physics course begins with explaining the material, exercises, question and answer, and at the end of the lesson the lecturer gives assignments. Learning is only conveying, seeking and discussing environmental physics knowledge. Physics teaching materials are less associated with real problems that exist around students such as energy crisis, environmental pollution, problems caused by lightning, building fire problems due to short circuit, and so on.

Based on the general and specific facts above, there has been a gap between the demands of the 21st century and laws and regulations and what has occurred in the learning process. If this is not done, it will be difficult to fulfill the objectives of the Physics Education Study Program, which is to produce excellent physics educators who are able to research and develop innovative work. Therefore it is necessary to innovate in the learning process of Environmental Physics courses. The proposed innovation is to reconstruct Environmental Physics learning by integrating ethno-technology to foster superior competence.

Reconstruction of Environmental Physics learning means improving learning components

based on a systems approach. The learning component as a system consists of curriculum, objectives, lecturers, students, materials, methods, media and evaluation [3]. Reconstruction of learning can be carried out on learning outcomes, structure of study materials, teaching materials, media, learning models, assignments and assessments [4]. Based on this, the reconstruction of Environmental Physics learning in this study was carried out on learning outcomes, study materials, models and evaluations.

Ethno-technology is all equipment owned by a particular community or social group along with the ways of using it, which are used to achieve goals or solve problems in dealing with certain situations and environments [5]. Ethno-technology is analogous to ethno-science. Previous research results state that contextual learning integrated with ethno-science can improve learning outcomes [6], conceptual mastery [7], and creative thinking [8]. Examples of ethnoscience that are integrated into learning physics are Javanese culture [9], national character based on local wisdom of Balinese culture [8], Bengkulu typical *Dol* music [10]. Based on the research results above, it can be analogized that the integration of ethno-technology in environmental physics learning is expected to foster the superior competence of prospective teacher students.

Environmental Physics learning innovation needs to prioritize personal experience through the process of observing, questioning, reasoning, and trying to increase student creativity. The learning process is not a transformation of knowledge from lecturers to students by memorizing a number of concepts that seem independent from real life, but more emphasis is placed on facilitating students to seek life skills from what they learn [11]. The model of learning developed in this study is in accordance with the needs of the field and to improve the superior competence of prospective physics teachers. Superior teacher candidates are prospective teachers who have comprehensive abilities and skills that exemplify personal development and the ability to interact effectively with various constituents in the learning environment [12]. The right 21st century skills to cultivate are critical thinking, problem solving, scientific communication, working in groups, and the use of information technology in learning. These skills can be cultivated through a comprehensive learning process, namely learning that connects the concepts learned with real problems in the daily lives of students.

The general objective of this research is to reconstruct Environmental Physics learning by integrating ethno-technology as an effort to create superior teacher candidates.

II. METHOD

The research design used is a mixed research design, namely mixing qualitative and quantitative methods with a sequential exploratory strategy [13]. A qualitative descriptive approach is used to reveal findings related to ethno-technology in bricks making process and evaluation of the Environmental Physics course. Quantitative methods are used to test the Ethno-technology Integrated Learning Model (EILM) with pre-experimental design. The instrument used is the superior competency of prospective teachers consisting of critical thinking skills, problem solving, communication, working in teams, and mastery of information technology as well as objective and environmental care. Data collection using test methods, questionnaires, observation and self-assessment. The quantitative method used the average data analysis, t-test and N-gain. In this study, the comparative analysis of N-gain and t test was used between the upper, middle and lower achievement groups. This grouping is based on the cumulative grade point average (GPA) in the previous semester.

III. RESULTS DAN DISCUSSION

The results of the evaluation and reconstruction design for the Environmental Physics course can be summarized as in the Table 1.

Table 1. The results of the evaluation and reconstruction design

No	Component	Evaluation Results	Recontruction Design
1	Structure of Study Materials	Lecture materials are in accordance with textbooks that are too general, global contextual	It is necessary to integrate local cultural and technological issues
2	Learning model	The conventional model with the methods of lecturing, discussion and question and answer tends to be teacher centered.	Project based learning model with a contextual approach, presentations and discussions. Strived to be more student centered.
3	Assessment of Student Learning Outcomes	Assessment of learning outcomes that have been carried out so far cannot measure the superior quality of a student	Assessment of student learning outcomes is obtained from the percentage results of pretest, posttest, midterm, final exams and assessment of project presentations and assignments

Based on Table 1, the structure of course study materials in the previous year was felt to be too general, not in accordance with the applied course descriptions. Therefore, lecture materials need to be related to local cultural issues and simple

technology. An evaluation of the learning model for environmental physics courses as mentioned in table 1, that the learning model used is conventional with the lecture, question and answer and assignment methods. This causes teacher center learning. Learning model innovation planned is project-based learning with a contextual approach. The use of a project-based learning model is in accordance with the results of previous research which states that this model can improve mastery of physics concepts [14], critical thinking skills [15], live's skills [16], social skills [17], and digital literacy [18]. The assessment of learning outcomes that have been carried out so far has not been able to measure the superior quality of a student, so it is necessary to develop authentic assessment instruments that can measure the superior competence of prospective teachers.

The application of EILM in the Physics Education study program to foster superior competence in each achievement group is shown in Table 2.

Table 2. t-test and N-gain in each group

Achievement Group	Subjects	Pretest Mean	Posttest Mean	<g>	t	p*	decision
Upper	7	240	308	0,60	33,080	0,000	significant
Midle	16	236	302	0,56	26,200	0,000	significant
Lower	7	228	292	0,51	20,558	0,000	significant

*) p = significance value with two-tailed test and 95% confidence level

Based on Table 2, in all achievement groups, the average posttest is greater than the pretest. The N-gain results of each group were between 0.3 to 0.7, this was in the moderate category [19]. The significance is 0.00, which means that there is a significant difference between the pretest and posttest. The results of the EILM implementation show that all indicators experience an increase in N-gain, both individually and in groups of achievement.

This result is in line with the research results of Sastrika, Sadia & Muderawan; Mettas & Constantinou and Dewi. The research results of Sastrika, Sadia & Muderawan [20] state that the application of a project-based learning model can improve critical thinking skills. The results of research by Mettas & Constantinou [21] state that project-based learning models can improve problem-solving skills. Dewi's research results [22] that project-based learning models improve critical thinking skills, collaborate, communicate and think creatively which are needed in the 21st century.

IV. CONCLUSION

The results of evaluation of Environmental Physics learning are used to reconstruct the structure of study materials, teaching materials and learning models by integrating ethno-technology. The implementation of the EILM can foster the superior competence of teachers candidate. This is evidenced by the N-gain value which is included in the medium and high category and is significant between the pretest and post test scores.

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