LOOK ACADEMIC PUBLISHERS
OPEN ACCESS

INTERNATIONAL JOURNAL OF ENVIRONMENTAL & SCIENCE EDUCATION
e-ISSN: 1306-3065
2018, Vol. 13, No. 10, 845-851

Evaluation and Reconstruction of Environmental Physics Courses

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ABSTRACT

Higher education has a very big challenge in the era of disruption. The teacher college through the Indonesian Ministry of Research, Technology and Higher Education has been recommended to revitalize the curriculum in accordance with the Indonesian National Qualifications Framework (INQF). However, this is still considered are insufficient, changes must be made to each subject resulting from revitalization. Therefore it is necessary to do an evaluation and reconstruction of the course. Reconstruction is the improvement of courses based on the need to review their relevance to the needs of everyday life. The purpose of this study is to evaluate and reconstruct the subject of Environmental Physics. Based on the evaluation of the Environmental Physics course at the Physics Education Study Program at the University of PGRI Semarang, it was found that the lecture material and learning methods needed to be changed by adjusting the needs. The results of the reconstruction of environmental physics courses are by integrating ethno-technology in the material and learning methods. With this integration it is expected that students will more easily understand the concepts of physics that are applied by society and how they affect the environment.

Keywords: evaluation, reconstruction, ethno-technology

INTRODUCTION

The 21st century is a century of knowledge characterized by technological advancements and their applications in all fields. In this century, qualified human resources are needed, skilled in learning and innovation. They must have critical thinking skills and problem solving, communication, collaboration, creativity and innovation and master information technology (Keane, Keane, & Blicblau, 2016). The development of information technology now enables major changes in learning in higher education. Teachers' colleges must pay attention to the skills problems of their graduates in facing the 21st century. The hopes of all parties to teachers' colleges are able to provide intellectual and professional capital to prospective teachers to be of high quality and competitive. Teachers' colleges needs to make curriculum changes that emphasize not only cognitive skills but also the character values and values of their students (Mergler & Spooner-Lane, 2012).

In accordance with Indonesian Ministry of Research, Technology and Higher Education Regulation No. 44 In 2015, universities are required to follow a INQF-based curriculum (Menristekdikti, 2015). Teachers' colleges has revitalized the curriculum based on the INQF, besides that it also follows the teacher education standards set by the government through Indonesian Ministry of Research, Technology and Higher Education

Article History: Received 5 July 2018 ◆ Revised 13 November 2018 ◆ Accepted 4 December 2018

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Number 55 of 2017 (Menristekdikti, 2017). These changes have not been sufficiently faced with current technological developments and community needs. Therefore it is necessary to do an evaluation and reconstruction of courses in order to improve lectures by adjusting to the needs of the community in daily life. Course evaluation and reconstruction are based on decisions about lecture material and learning methods that are considered satisfactory and the need for change. Reconstruction of courses is carried out using certain procedures, which involve evaluating and using evaluation data to improve courses (Suciati, 2001).

Reconstruction of the course is to reconstruct the learning process according to the new goal. The learning process can be interpreted as an activity where there is delivery of learning material from an educator to the students he has. The components that influence the learning process are the presence of students, educators, learning media, learning materials and the existence of learning plans. Therefore, in the context of the reconstruction that needs to be rearranged are material, media and learning plans. Before reconstructing, it is necessary to evaluate the learning process. To evaluate the success of the learning process is not enough just based on the assessment of student learning outcomes, but needs to reach out to the program design and implementation of learning programs (York, Gibson, & Rankin, 2015). The design of the learning program is assessed from the aspects of the objectives to be achieved or the competencies to be developed, the learning strategies to be applied and the content of the learning program. Whereas in program implementation that needs to be reviewed is the learning and learning process. A number of criteria that can be used to evaluate the learning and learning process are: consistency with activities contained in the learning program, implementation by lecturers, implementation in terms of students, student attention, active students, opportunities given to apply learning outcomes in real situations, patterns interaction between lecturers and students and the opportunity to get feedback (Sudjana & Ibrahim, 2004).

Environmental physics is an applied course in physics education study programs. After attending the lecture, students are expected to be able to explain and link physics with environmental problems in everyday life. Students need to understand how physics scientists contribute by overcoming social problems with aspects of physics. The social problem that is the focus of this course is that people use safe and clean energy now and in the future, the second is a way to deal with the predicted climate change (Boeker & van Grondelle, 2011). Technological developments are not always understood by the lower class, many of them carry out production activities for generations without considering the economic and environmental impacts. Based on the analysis above, this course needs to be more frequently evaluated and reconstructed on the progress and development of technology and community needs.

This study aims to evaluate and reconstruct environmental physics courses by basing them on everyday people's needs and social impacts in society. The results of evaluation and reconstruction are expected to be used for the basis of improving learning to improve the competence of prospective teachers.

METHOD

This research was carried out in the Physics Education Study Program at the University of PGRI Semarang. This type of research is qualitative with methods of collecting data from documents, interviews and questionnaires. Course evaluation is carried out after the odd semester of Environmental Physics lecture in 2016/2017. Evaluations include the Semester Learning Plan (SLP) format, study material organization, teaching materials, media and learning methods. The evaluation results were used to reconstruct the subjects discussed in the Focus Group Discussion (FGD) by presenting experts and all lecturers. Experts provide assessments and responses related to learning devices. The reconstruction results will be applied in the odd semester of 2017/2018.

RESULTS AND DISCUSSION

The evaluation results of the course are listed in **Table 1**. The main things that become the discussion for improvement are the organizational materials for study materials, teaching materials, media and learning methods. The evaluation also produced a study that lecture material was felt to be very theoretical, far from being applied in people's daily lives. Therefore it is necessary to look for examples of applications that are in accordance with the study material such as ethno-technology in brick making. Ethno-technology is the entire equipment owned by a particular community or social group along with the ways of using it (Syarifudin, 2017). Ethno-technology is a part of ethno-science that specifically examines traditional technologies used by people in making goods. Similar studies, which integrate local culture and wisdom, have been examined by experts in Indonesia. Learning science is associated with *Sundanese* culture about photosynthesis (Djulia, 2005),

Table 1. Results of Evaluation of Environmental Physics Courses

Component	Evaluation result	Reconstruction Design
SLP format	Not in accordance with the post revitalization curriculum	Customized
Event Unit and Lecture Contract	Not available	Need to be made
Formulation of Graduate Learning Outcomes	Formulation according to standards but not operational	It needs to be added to the daily problems such as ethno-technology
Formulation of Subject Learning Outcomes (SLO) and expected capabilities (sub-SLO)	Not yet available SLO and sub-SLO	Enter SLO and sub-SLO
Formulation of Course Descriptions	It only explains the cognitive competencies of students after attending lectures, less concrete in adding excellence	It is necessary to explain the contents of this course and what competencies are evaluated.
Study Material Organization	Lecture material is in accordance with textbooks that are too general, global contextual.	Local cultural and technological issues need to be integrated
Instructional Materials / Modules	Not yet created, only uses existing references	There needs to be a separate module that has local context
Instructional Media	The learning media used so far are only through power points that are displayed using projector, while students are not given lecture material modules.	The media used are LCDs, laptops, smartphones, videos, triggers (cases) and lecture modules
Learning Model / Method	The conventional model with the lecture method, discussion and question and answer are more likely to be teacher-centred learning.	Project model based learning with contextual approaches, presentations and discussions. Strived for more student-centred learning.
Time and Academic Credit Unit Estimates	-	-
Student Assignments	Student assignments are still minimal. Need to increase quantity with the aim that students are creative, active and independent.	Increasing the quantity of student assignments and arranging projects that can be uploaded in social media in various forms
Student Learning Outcomes Assessment	Assessment of learning outcomes carried out so far is not able to measure the superior quality of a student, so it is necessary to have an assessment based on high-level thinking skills and have objective character and care	Assessment of student learning outcomes is obtained from the results of the percentage of pre-test, post-test, midterm, final semester exams as well as assessment of project presentations and assignments.

tobacco planting culture in Temanggung (Sudarmin, 2015), palm sugar production (Sumarni, Sudarmin, Wiyanto, & Supartono, 2016), *Balinese* culture (Suastra, 2005), pre-structured system of prey through ethno-science studies (Sarwanto, Sulistyo, Prayitno, & Pratama, 2014), and others.

Ethno-technology on brick making is considered appropriate to be used as an example of the application of physics in everyday life in accordance with the theme of the course and impact on the environment. Brick making in traditional communities consists of the process of selecting materials, printing, drying and burning. Every manufacturing process is always related to soil, water and air. Physics studies relate to soil, water and air in the process of making bricks according to the study of environmental physics courses (Nuroso, Supriyadi, Sudarmin, & Sarwi, 2018). So that brick-making technology can be integrated in environmental physics lectures.

The organization of study material needs to be adjusted to the results of the evaluation. The evaluation results require integration with local culture and technology. **Figure 1** shows the organization of study material for environmental physics courses after being reconstructed. There are those that remain unchanged according to the main theme of the study material, which is about soil, water and air. The organization of

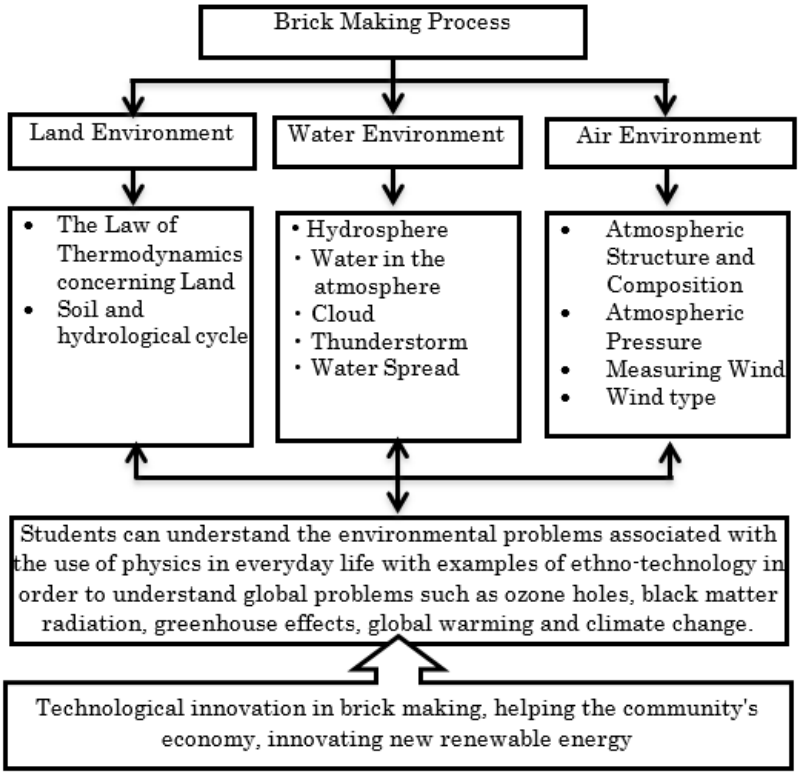

Figure 1. Study Material Organization

Figure 2. Display of teaching material applications via mobile

study materials is arranged in the form of teaching materials in the form of modules and power points that can be easily accessed by students. In addition to printed teaching materials, students are also given teaching materials in the form of applications that can be accessed through mobile phones. Application of environmental physics courses as shown in **Figure 2**.

In addition to study materials and teaching materials, the thing that needs attention in reconstruction is a learning model that gives students more opportunities to explore. The model is based on a contextual approach. There are three scenarios of contextual learning approaches that are based on goals, project-based, and oriented towards inquiry (Hudson & Whisler, 2013). By adapting the Hudson and Whisler scenario, an integrated ethno-technology learning approach uses a project-based scenario. Through project-based learning it opens the possibility for students to take advantage of their previous expertise and knowledge, and to build on their experiences gathered in various practice locations and build new knowledge that is action-oriented and socially relevant. The application of contextual learning can effectively improve mastery of concepts and student character development (Dewi, Sarwi, & Yulianto, 2015). The project given to students is a simple research that utilizes the concept of physics in brick making. The scenarios of the integrated environmental physics learning model project-based ethno-technology consist of five phases, as follows.

1) Students form groups and choose topics. Topics to choose from are materials and mixtures of bricks, drying, and burning.
2) Students plan their projects and present plans to each other.
3) Students hold daily meetings where they report on the work done, discuss their learning, and plan next week.
4) Students prepare and make project presentations in front of the class.
5) Students prepare a comprehensive report on the project (both content and process) and participate in the collective evaluation process, involving all students in the group and relevant academic staff.

In the model students are given projects or assignments in the form of simple research on the study of brick making observations. Simple research results are presented in front of the class, uploaded to social media owned and compiled a report on the results of problem solving. With these activities the final assessment of students does not only depend on cognitive tests but more comprehensively including cognitive, affective and psychomotor and other skills such as presentation skills (Shauki & Benzie, 2014). The use of this project-based learning model is in line with Mahasneh and Alwan's research stating that project-based learning can improve student learning and self-efficacy outcomes (Mahasneh & Alwan, 2018). Science / physics education is very suitable as subject and scope for these researches (Baran, Maskan, & Yasar, 2018).

The module application on the mobile phone (**Figure 2**) consists of objectives, instruction material, observation task and bibliography. The application is made through the Adobe Air application. To run the application, students must first install Adobe Air, then copy and run the Environmental Physics Module application. By using the module application on this smartphone, students can learn lecture material whenever and wherever.

The results of the reconstruction of the course with all the devices and models were reviewed through the FGD. 3 different experts as the main discussers and all lecturers of physics education study programs became participants of the discussion. The results of expert analysis relating to evaluation models and devices are listed in **Table 2** and **Table 3**. In **Table 2** it can be seen that 3 experts have different skills with a long working period. In **Table 3**, we can see that there are no judgments from the three experts that are not valid. They judge that every aspect is valid, quite valid and very valid. Aspects in the model consist of rationality, literature review, model development, model characteristics, model scenarios, social systems, reaction principles, support systems, instructional and accompaniment impacts, learning planning, application of scenarios, application of social systems, application of reaction principles, environment learning and evaluation. The conclusion of the assessment of the three experts is all good. Thus the learning model can be used in learning environmental physics courses.

Table 2. Expert Judgment Data

Expert	Qualification	Areas of Expertise	length of work
Expert 1	Prof. Doctor	Educational Research and Evaluation	31 years
Expert 2	Doctor	Science Education	24 years
Expert 3	Doctor	Education Management	24 years

Table 3. Results of Expert Judgment on the Model

Aspect	Expert 1	Expert 2	Expert 3
Rationality	2 QV	1 VV, 1 V	2 QV
Literature Review	7 V	6 VV, 1 V	7 V
Model Development	2 QV	2 VV	1 V, 1 QV
Characteristics of the Model	5 V, 1 QV	5 VV, 1 V	5 V, 1 QV
Model Scenario	7 V	5 VV, 2 V	7 V
Social System	2 V	2 VV	2 V
Principle of Reaction	2 V	2 VV	2 V
Supporting System	1 V	1 V	1 V
Instructional and accompaniment impacts	2 QV	1 VV, 1 V	2 QV
Learning Planning	2 QV	2 VV	2 QV
Application of Scenarios	2 QV	2 VV	1 V, 1 QV
Application of social systems	4 V	3 VV, 1 V	4 V
Application of the Reaction Principle	3 V	3 VV	3 V
Learning Environment	3 V	3 VV	3 V
Evaluation	3 V	3 VV	3 V
Conclusion	**Good**	**Good**	**Good**

Note: V = valid, QV = Quite Valid, VV = Very Valid

CONCLUSION

Based on the data analysis of this study it can be concluded that an evaluation of environmental physics courses based on needs has been carried out. The evaluation results are used to reconstruct by changing the organization of study materials, teaching materials and learning models. Study material organizations continue to include the main discussion about land, water and air which begins with the process of making bricks. Teaching materials are arranged not only in print and power point modules but also in mobile applications. While the planned learning model is a project based learning integrated ethno-technology. The recommendation of the next study is to test the effectiveness of integrated ethno-technology model based learning models on student learning outcomes.

Disclosure statement

No potential conflict of interest was reported by the authors.

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