Development the Science Learning Plan Based on Pedagogy for Sustainability to Grow Environmental Literacy Students

IOP Conf. Series: Journal of Physics: Conf. Series **1233** (2019) 012108 doi:10.1088/1742-6596/1233/1/012108

Development the Science Learning Plan Based on Pedagogy for Sustainability to Grow Environmental Literacy Students

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Abstract. The objectives of this research are (1) to find out the characteristics of pedagogy for sustainability developed to cultivate environmental literacy in global warming themes; (2) to produce science learning design-oriented pedagogy for sustainability that has been validated and qualified to be tested in school. This research used development design (Research and Development) refers to Borg and Gall model (1983: 775). Data collection techniques that were used in this study were the assessment of pedagogy for sustainability planning (lesson plan, worksheet, and assessment instruments). The data were analyzed descriptively through qualitative and quantitative. This research succeeded in developing science learning tools based on pedagogy for sustainability that had been validated by experts with a very good category. The science learning developed has characteristics that have pedagogy for sustainability components and it potential to cultivate environmental literacy. The pedagogy for sustainability components that were embedded in the science instruction includes (1) system thinking and understanding of interconnectedness, (2) longterm, foresighted reasoning, and strategizing, (3) stakeholder engagement and group collaboration, (4) action orientation and change- agent skills.

Keywords: Characteristics of pedagogy; Design; Students.

1. Introdution

Recently, human behavior to care about the environment has not been fully realized. This is shown by the fact that leads to the exploitation of natural resources without thinking of the present and future generations. For example there are still many people who do throwing garbage out of place, inappropriateness in managing waste, conducting behavior that adds CO_2 accumulation, using of energy without thinking about renewable energy innovations, using of textile dyes for food additives, and improper diet. This fact becomes a great thought in changing human behavior that leads to the sustainability of the environment of life in nature. This is important in the sustainability of resources for future generations. Education plays an important role in changing the behavior of learners resulting in a comprehensive learning outcome both cognitive, psychomotor and attitude. The attitudes aspect becomes urgently to lead positive human behavior. Universities play an essential role in producing qualified teachers generations who lead character, skills and cognitive skills. This educator is then expected to be able to package innovative learning and develop the attitude of learners.

Global warning is an issue that to be trending issues recently. Increasing of the temperature happen in global area o the world. Air pollute are most factor that caused global warming. Carbondioxide, nitrogenoksida and methane are substantes that accumulates as green house effect gas. Caring attitude towards environmental sustainability and natural resources is an urgency recently. Education that leads to the sustainability of resources and the environment certainly needs to be integrated into science

subjects. According to the views of science, it reflects a holistic problem in real life. Natural science can be studied from several aspects, namely as a body of knowledge, a way of thinking, a way of investigation and its related to technology and society.
To be able to act and care about the environment, learners need to be competent in identifying environmental issues, analyzing environmental issues, evaluating the problem solving, designing and determining actions. Some of these abilities are aspects of the quality of environmental literacy (environmental literacy) of learners. Attitudes and cares about the environment are shaped through a process of thinking where students are invited to analyze issues to determine action on emerging issues. This thought process will support the attainment of a person's sensitivity to the environment. Attention to the environment as an internalization of the actions that become habitual to do in thinking and acting on an issue. To form the abilities and attitudes required an appropriate pedagogy model (pedagogy for sustainability). Pedagogy for sustainability develops thinking skills (system thinking), thinking on foresight, group collaboration in the problem solving, and action orientation to act accordingly. This model can be done through the problem solving learning, learning through real word, and experiential learning. Such learning can develop outcomes in the form of changes in individual behavior towards an environmental issue [1].

The ability to determine a learning strategy is one of the standards that science teachers must be mastered. The science teacher must master the standards as stated in the NSTA. The NSTA (National Sience Teacher Association) recommends Standards for Science Teacher Preparation. This standard contains a number of standards that must be possessed by teachers including content standards, nature of science, inquiry, Issues, general skills of teaching, curriculum, science in the community, assessment, safety and welfare, professional growth. This standard is consistent with the vision of the NSES (National Science Education Standards). The NSTA also recommends that primary and secondary school science teachers need to have interdisciplinary science skills. This is the urgency of integrated science learning (integrated science). Science lessons in junior high schools are developed as integrative science subjects. It isn't a disciplinary education. Both are applicative-oriented education, developing thinking ability, learning ability, curiosity, and the development of caring and responsible attitude towards the natural and social environment. Integrative science has the meaning of combining various aspects of the domain of attitude, knowledge, and skills. Substantially, science can be used as a tool to develop attitudes, knowledge, and skill domains. Science needs to be learned to cultivate a caring attitude toward the sustainability of nature for future generations [2].

The purpose of this research is to produce an integrated science learning device with pedagogy for sustainability to cultivate decent environmental literacy to be tested and to know the characteristics of learning devices developed.

The rest of this paper is organized as follow: Section 2 describes the proposed research method. Section 3 presents the obtained results and following by discussion. Finally Section 4 concludes this work.

2. Research Method

The research was conducted using Research and Development model [3]. The instrument used in this research is a product assessment sheet. Data from product model assessment were analyzed qualitatively and quantitatively.

3. Result and Disussion

This section presents the results used and the proposed discussion.

3.1. Science Instruction

Science as a way of thinking, a way of investigating, a body of knowledge, and its interaction with technology and society. It can be abstracted that in science there are dimensions of the way of thinking, a way of investigation, the building of science and its relation to technology and society. This becomes a substantial substance of the importance of science teaching which develops its

scientific process for the formation of the mindset of learners [3]. The word science as "both a body of knowledge and a process". Science is defined as the building of science and process. Furthermore, science is defined to have three important elements of attitude, process, and product.

Science has three major elements: attitudes, processes or methods, and products. Attitudes are certain beliefs, value, opinions, for example, suspending judgment until enough data has been collected relative o the problem. Constantly endeavoring to be objective. Proces or methods are investigating the problem, for example, making hypotheses, designing and carrying out experiments, evaluating data and measuring. Products are facts, principles, laws, theories, for example, the scientific principle: metals, when heated expands [4].

Science has holistic objects and issues so that it needs to be presented holistically. Integrated science presents aspects of physics, chemistry, biology, earth sciences, astronomy and other aspects of the natural sciences. Integrated sciences are presented based on a contextual approach to connecting science with daily life, personal and direct, placing one of the main ideas, containing problem-solving. In its presentation, science is presented with a unified concept [5]. The integrated approach involves the scientific process, organizing principles, organizing the natural integration of scientific knowledge and its application in everyday life. Besides that, in an integrated approach, students are expected to be able to relate to other fields including physics, astronomy, chemistry, geology, biology, technology, environment, and safety healthy [6].

3.2. Process of developing the product

This research was conducted to develop science learning tool based pedagogy for sustainability to improve environmental literacy that it supports the growth of environmental attitude of learners. This research is done through the steps including define, design dan develop. Defining step consist of some steps include exploring study to know the problem in school. Previous research on the case study of PCK (Pedagogical Content Knowledge) of science class 8 teachers in 2013 implementation. Based on preliminary exploration studies, students' actions to protect the environment still need to be grown, including disposing of waste according to their characteristics, energy saving action, environmental preservation for future generations. The environmental attitude of learners needs to be instilled through habits that are integrated with learning activities.

Designing step is design pedagogy for sustainability learning process that includes learning plan (Syllabus, lesson plan, worksheet, and assessment sheets). The scenario developed based on pedagogy for sustainability covering four components include system thinking and understanding of interconnectedness, (2) longterm, foresighted reasoning, and strategizing, (3) stakeholder engangement and group collaboration, (4) action orientation and change-agent skills.
Developing step was done by validating the product to the expert. The following data generated from the assessment of learning scenarios is shown in Table 1 below.

Table 1. Score of each component of learning device

Component of learning scenarios	**Score**
Syllabus	28
Lesson plan	95
Worksheet	45
Assessment	38
Total	206
Category	Very good

Based on the quality criteria of learning scenarios that were developed, this product has *very good criteria*. The quality criterias of the product were shown in Table 2 below.

Table 2. Quality of Product

Formula	Range	Criteria
X> $\overline{Xi}$ + 1,8. Sbi	X > 184.79	Very good
$\overline{Xi}$ + 0,6 Sbi < X ≤ $\overline{Xi}$ + 1,8.Sbi	149.59< X ≤ 184.79	Good
$\overline{Xi}$ - 0,6 Sbi < X ≤ $\overline{Xi}$ + 0,6. Sbi	114.40 < X ≤ 149.59	Enough
$\overline{Xi}$ - 1,8.Sbi < X ≤ $\overline{Xi}$ - 0,6.Sbi	79.20 < X ≤ 114.40	Less
X ≤ $\overline{Xi}$ - 1,8. Sbi	X ≤ 79.20	Very less

Based on the results of the assessment of experts, suggestions for product improvement include (1). Goals are made at each meeting, (2). The question of apperception is written, (3). Activities based on the worksheet are clearly referenced, (4). Customize step by topic in the lesson plan with activities in the worksheet, (5). A follow-up plan is also written, (6). Consistency between goals in the lesson plan and those in the worksheet), (7). A Worksheet is titled according to the activities in the lesson plan.

3.3. Pedagogy for Sustainability

Pedagogy for sustainability is part of sustainable development. Sustainable development as follows: Sustainable development is development that meets the needs of the future generation to meet their own needs. Sustainable development suits the needs of people now without having to reduce the needs of future generations [7,1]. Pegagogy for sustainability consist of four components including (1) system thinking and understanding of interconnectedness, (2) longterm, foresighted reasoning, and strategizing, (3) stakeholder engangement and group collaboration, (4) action orientation and change-agent skills [1]. Pedagogy is a way of teaching to integrate sustainability competence. The methods that can be focused are real-world learning, critical problem-solving and experiential (active) learning [1]. Pedagogy model to achieve sustainability competence can be shown in Figure 1 below.

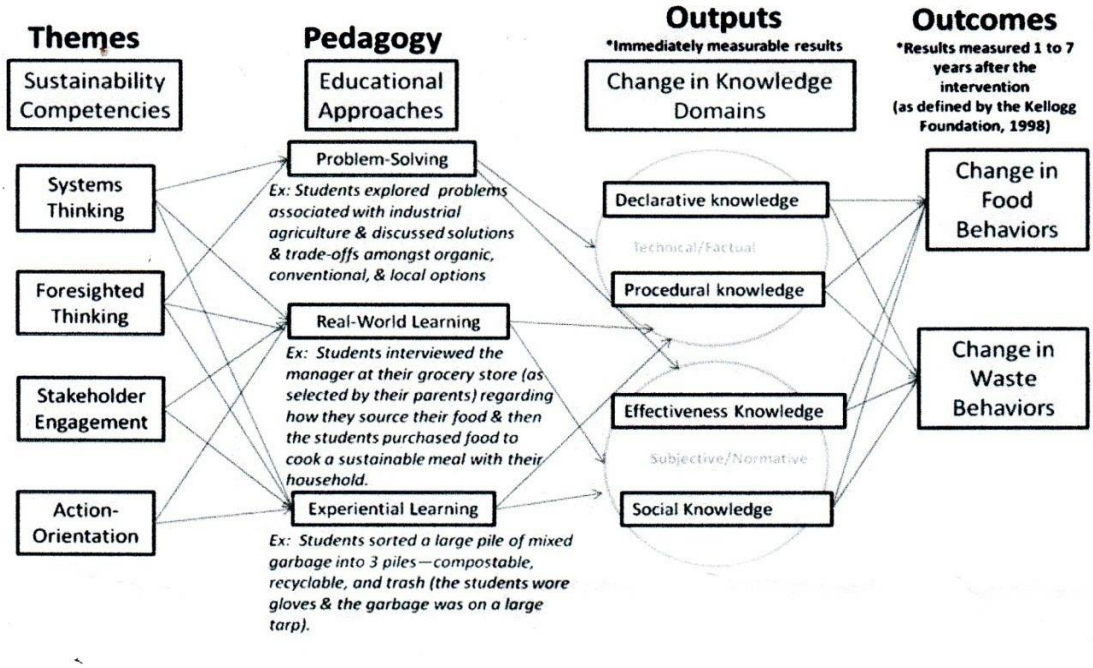

Figure 1. Approach for Targeting Behavior Change Outcomes

3.4. Environmental Literacy

This product was developed that oriented pedagogy for sustainability to improve environmental literacy. Literacy is the capacity of students to apply knowledge and skills in key subject areas and to analyze, reason, and communicate effectively as they pose, solve, and interpret problems in a variety of situations [8]. Environmental literacy is a measure of a person's knowledge about the interactions of humans and their environments, environmental issues, and the various connections in ecological systems [9]. Environmental literacy is knowledge of environmental concepts and issues; the attitudinal dispositions, motivation, cognitive abilities, and skills, and the confidence and appropriate behaviors to apply such knowledge in order to make effective decisions in a range of environmental contexts [10]. Individuals demonstrating degrees of environmental literacy are willing to act on goals that improve the well-being of other individuals, societies, and the global environment, and are able to participate in civic life. There are seven elements of environmentl literacy including:

a. *Affect (e.g., environmental sensitivity, attitudes, and moral reasoning).*
b. *Ecological knowledge.*
c. *Socio-political knowledge (e.g., the relationship of cultural, political, economic, and other social factors to ecology and environment).*
d. *Knowledge of environmental issues.*
e. *Skills pertaining to environmental problems/issues and action strategies, systemic thinking, and forecasting.*
f. *Determinants of environmentally responsible behavior (i.e., locus of control and assumption of personal responsibility).*
g. *Behavior (i.e., various forms of active participation aimed at solving problems and resolving issues)* [9].

The domian of environmental literacy was shown in Figure 2 below [10]:

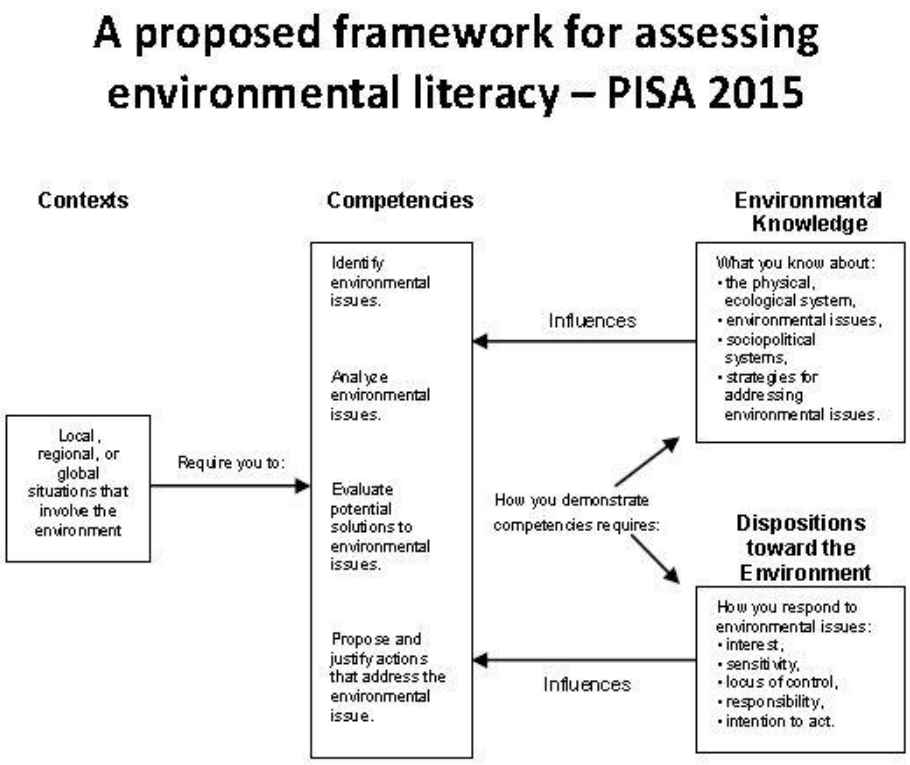

Figure 2. Domain of environmental literacy

Developing environmental literacy is a major challenge for our school system. It is the disposition of teachers towards the environment and environmental education which determines to a large extent whether learners are educated to become adults who take the responsibility to maintain the environment and improve quality of life [11].

3.5. Characteristic of science learning oriented pedagog for sustainability

The environment is one of the most crucial topics of the world after all. This is an important task that imposes higher education institutions and in this task; universities should bring up the next generations of individuals who have advanced knowledge, attitude, behavior and value related to the environment, who care environmental issues and who can see connection among them who also aware of needs of next generation afterwards [12].

In this research, learners are given a case of high air pollution that encourages them to think in terms of science, health, social, and economic environment. Subsequent activities lead students to think about the future with the current situation. Furthermore, students are motivated to predict the conditions in the future. After predicting, students are facilitated to mitigate efforts to minimize global temperature rise. Through pedagogy-based sustainability-based learning activities, sustainability competence can develop. This learning experience can be done continuously so that environmental literacy (environmental literacy) and attitudes toward the environment can be internalized.

If environmental literacy can be developed in individuals then awareness, knowledge, and sensitivity of natural balance and how this balance would be affected by people would be vaccinated [12,13]. Environmental literacy is knowledge of environmental concepts and issues, behaviors, motivations, cognitive skills and skills, and appropriate behavior to apply knowledge to make effective decisions in an environmental context. A person with good environmental literacy tends to have a desire to act on purpose to improve relationships with other individuals, communities and the global environment and to participate in community life.

Students who had an interdisciplinary course with a focus on creating a more humane and environmentally sustainable future developed an increased caring about the future of society, an increased belief that they can make a difference, and an increased willingness to participate in solving societal and environmental problems (Longitudinal data about the long-term impact on the students is still being collected) [12,13].

4. Conclusion

This research succeeded in developing science learning device based on pedagogy for sustainability in global warming topic that has been validated by experts with very good category. The developed learning devices have characteristics that have pedagogy for sustainability and the potential to cultivate environmental literacy. The pedagogy for sustainability components in learning tools are: (1) system thinking and understanding of interconnectedness, (2) longterm, foresighted reasoning, and strategizing, (3) stakeholder engangement and group collaboration, (4) action orientation and change agent skills.

Acknowledgment

The authors thank to the Institute of Research and Community Service, Yogyakarta State University for the funding of this work through DIPA Yogyakarta State University 2017.

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