Pedagogical content knowledge (PCK) of prospective biology teacher on respiratory system material to education for sustainable development

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Abstract. Pedagogical content knowledge is the blending of content knowledge and pedagogical knowledge (PCK) into a specialized knowledge for teaching of specific subjects. In this study, what is meant by PCK for education for sustainable Development is the integration of pedagogy knowledge, knowledge content and three aspects in sustainable development, namely social, economic and environmental together so as to create Education to achieve 17 Sustainable Development goals (SDGs). The purpose of the study was to find out preservice biology teacher\(^1\) PCK to Education for Sustainable Development in teaching the respiratory systems. This study was used by two female of prospective biology teachers who were in their final year at the undergraduate level of Biology Education. Data was collected qualitatively through documents of teaching and learning plan and observation during the learning process. Prospective biology of teachers A and B shows the ability to learn respiratory systems that support education for sustainable development. This can be seen in the framework PCK, which is a component of perspectives on economic, social and environmental that is simultaneously and harmonious, material in curriculum context, learning startegy, evaluation and learning outcomes. Leads to the sustainability of present and future life, especially those related to the respiratory system. Learning by teacher A and B aligns with the achievement of goals of Sustainable Development.

1. Introduction
Sustainable Development, in general, is a human effort to improve the quality of life while still trying not to exceed the ecosystem that supports its life. According to the laws of the Republic Indonesia number 32 of 2009, Sustainable Development is defined as a conscious and planned effort that integrates environmental, social and economic aspects into development strategies to ensure the integrity of the environment as well as the safety, capability, welfare, and quality of life of present and future generations. Based on the President's Council on Sustainable Development in The United States of America "USEPA, 2013" Sustainable Development is a development process that can increase the level of the economy, preserve the environment and social conditions for the benefit of present and future generations.

Sustainable Development is scheduled by the United Nations, that by 2030, all the nations of the world have achieved 17 Sustainable Development Goals (SDGs). This is an invitation aimed at...
developed and developing countries in a global partnership to act to end poverty and deprivation. It must proceed in accordance with strategies that improve health and education, reduce inequality, and promote economic growth. Everything is done while overcoming environmental changes and working to preserve our oceans and forests. This will create peace and prosperity for people and the planet, now and in the future [1].

The existence of Sustainable Development created by the United Nations cause all individuals are expected to understand the meaning and implement it in daily life. Based on this, the United Nations through UNESCO (United Nations Educational, Scientific and Cultural Organization) disseminates the understanding of Education for Sustainable Development concepts through education both formally and informally, called Education for Sustainable Development (ESD). This time there are still many communities including teachers and students who do not understand what is meant by Sustainable Development and Education for Sustainable Development. This is seen in several studies showing that in-service teacher understanding about interrelationship between the three component of ESD is still minimal, some teacher hold misconception about the concept of ESD, SDGs were still largely unknown to the teaching staff. For this reason, it is necessary to provide an understanding of Sustainable Development in the community, including teachers and students in schools [2]. One of the ways is by formal education through biology teacher prospectives in practical activities at the school following the material taught based on the applicable curriculum so it will be more effective [3]. After learning, students are expected to understand the concepts in teaching material according to the curriculum and have an attitude that is awareness of sustainability and also skilled in implementing an understanding of sustainability in daily life.

In carrying out classroom learning to teach specific topics, prospective teachers must have simultaneous pedagogical content and knowledge, called Pedagogical Content Knowledge (PCK) [4], this is so that learning becomes effective to help students construct their knowledge [5]. Education for Sustainable Development (ESD) requires not only a well-designed ESD program but also taught by professional PCK teachers. Pedagogical Content Knowledge (PCK) is “integration of content knowledge and pedagogical knowledge in particular topics which is organized, represented and adapted to the diverse interests and abilities of learners, and presented for instruction” [6]. It is essential for effective teaching and learning [7].

In this study, what is meant by PCK for Education for Sustainable Development is the integration of pedagogy knowledge, knowledge content and three aspects in sustainable development, namely social, economic and environmental together [8] so as to create Education to achieve 17 Sustainable Development goals (SDGs).

2. Methods
The participant of this study were two female of prospective biology teachers in their final year at the undergraduate level of Biology Education and who were interested in Education for Sustainable Development. Before making a teaching and learning plan and implementing learning in high school, they are given an understanding of ESD and 17 goals of Sustainable Development. In this activity, discussion was conducted. The concept trained is to use the notion of “conscious and planned efforts that integrate environmental, social and economic aspects to ensure the integrity of the environment and the safety, capability, welfare, and quality of life of present and future generations”.

Once teachers have developed an understanding of Education for Sustainable Development, they then need to be able to translate it into their pedagogy, or in other words, make it accessible for the children in their classrooms. Each topic has its methods for teaching that help students learn the best way, and this makes the topic of specific to PCK. In this study, the integration of the concept of ESD in teaching material is a specific topic. Furthermore, they are trained on how to integration of pedagogy knowledge, knowledge content and three aspects in sustainable development, namely sociocultural, economic and environmental together so as to create Education to achieve 17 Sustainable Development goals (SDGs). The challenge of teaching material that must be solved by biology teacher
prospectives is the Respiratory System for high School students. The two prospectives are required to make the teaching and learning plan.

Data is collected qualitatively through documents of teaching and learning plan and observation during the learning process. PCK’s analysis to Education for Sustainable Development uses framework 6 components: perspective of sustainable development, material in curriculum, issue/ context, instructional startegy, evaluation and learning outcomes [9]. This is facilitate prospective teachers to develop their understanding and professionalism in breathing system learning to Education for Sustainable Development.

3. Result and Discussion
Finding from documents of teaching and learning plan and observation during in the high school learning are representation of an understanding of Education for Sustainable Development into their PCK. The prospective teacher’s PCK were analyzed according to 6 components: perspective of sustainable development, material in curriculum, issue/ context, instructional startegy, evaluation and learning outcomes, as show in Table 1. Table 1 is the PCK to Education for Sustainable Development on Respiratory System in high school, this is the result teaching and learning plan which has been modified to facilitate understanding of Sustainable Development to high school student, which is made by prospective teachers A and B.

| Table 1. Pedagogical Content Knowledge (PCK) for Sustainable Development of prospective biology teachers learning on Respiratory System in high school |
|---|---|---|---|---|---|
| Prospective Biology Teacher | Component of PCK to Support Education for Sustainable Development | Perspective of Sustainable Development | Material in curriculum | Issue/ Context | Instructional Strategy | Evaluation | Learning outcomes |
| | | Ec | S | En | |
| A | interconnected shows sustainability | √ | √ | √ | Structure and function of organs, respiratory mechanisms, disorders and diseases | Smoking and its effects on respiratory system | Problem Based Instruction | Essay test, assessment of student worksheets | Kognitif knowledge and the product works on the worksheet: problem solving to prevent cigarette smoke so as not to interfere with the health of the respiratory system |
| B | interconnected shows sustainability | √ | √ | √ | Structure and function of organs, respiratory mechanisms, disorders and diseases | Smokin g fish process in village of Bangi | Project Based learning | Multiple choice test and non test: Product | Critical thinking and Product: project report real activity in fish smoking to provide problem solving due to the presence of smoke that disrupts the health of the respiratory system |

Information:
Ec : Economy, S : Social-cultural, En : Environment

In addition to the information, analyzed PCK to Educational for Sustainable Development of prospective teachers can be seen from the learning startegy in more detail used in Respiratory System learning is as follows: The strategy for the prospective teacher A is as follows:
Students analyze disorders and diseases of the respiratory system and associate organ structures and functions in the respiratory mechanism with the following activities: at the beginning of learning student facilitated by video shows about disease disorders caused by cigarette smoke namely lung cancer, students discuss in groups and present why smoking has a negative impact on smokers and the environment around it? The student activities are guided by worksheets with several problems that must be answered by students: (1) Can you analyze which substances cause disruption to health and the environment ?; (2) If a person has lung cancer, his organs and functions certainly cannot run properly. What is the condition of the organ and its function in someone who has lung cancer ?; (3) Does your family smoke, how many people smoke? If one person spends 1 pack of cigarettes a day, and 1 pack of cigarettes costs Rp. 20,000; - How much is your family spending in one year to buy cigarettes?; How to keep the respiratory system healthy?

The value of sustainability presented by prospective biology teacher A on the material of the human respiratory system is through a case study of smoking habits. That there must be a continuation of normal or healthy conditions in the organ and mechanism of the respiratory system. Smoking can cause cigarette smoke, which can pollute the air around smokers so that it can cause interference and respiratory disease for smokers and non-smokers. One disease is lung cancer. The disadvantage from an economic perspective is that it requires funds to buy cigarettes and treat diseases. Then you must stop smoking.

The learning strategy in the prospective teacher B is as follows: Students analyze disorders and diseases of the respiratory system and associate the structure and function of organs in the respiratory mechanism with the following activities: at the beginning of learning students are facilitated with video shows about the process of smoking or making smoked fish in the village of Bangi, in the video shows a worker in smoking fish are very close to a thick and large collection of smoke without using a mask. Students are given a problem to solve at a certain time in the project activity with the Worksheets: how is the negative impact caused by smoke for workers in the process of smoking fish and for the surrounding environment? What is the solution that must be done so that the work of fish springs that are a source of income for the people of Bangi village can continue to be carried out but it does not have a negative impact on workers and for the surrounding environment? After showing the video students in groups made a project design. The completion of the project was carried out with actual activities by students by visiting the smoking fish site in Bangi village not far from the school, seeing the smoke on the environment, conducting interviews with workers regarding perceived health problems. After knowing the real conditions in Bangi village, students made a solution to solve the effects of smoke from the smoking fish process. In the worksheet there are several questions as enrichment (1) What are the respiratory problems experienced by workers? (2) How does smoke enter the respiratory system of the workers? If there is a disorder of lung infection, what is the respiratory mechanism that occurs? Do you think that if the smoking fish process interferes with the health of the workers and pollutes the surrounding environment, the activity of smoking fish that is a source of income must be stopped? Project results are presented and discussed on a designated day.

The value of sustainability presented by prospective biology teacher B on the material of the human respiratory system is through the case of fish fogging in the village of Bangi. That there must be a continuation of normal or healthy conditions in the organs and mechanism of the respiratory system even though there is a process of fumigating fish as a breakaway for the community in the village of Bangi. This is done by way of hauling smoke so as not to pollute the environment which causes interference with the interpretation system for workers and surrounding communities.

Table 1 and a description of the learning strategy used by the prospective biology teacher above shows that prospective biology teachers have differences including learning strategy used, issues, evaluation and learning outcomes. Both show differences in strategy but to go to suitable harmony among the three main dimensions perspective Education for Sustainable Development (Economy, Social-cultural and Environment). Shows prospective teacher B has involved students in concrete actions in their environment. The visible equations are concepts that are raised, namely Structure and function of organs, respiratory mechanisms, disorders and diseases. During the learning process it also
appears that the prospective biology teacher has the same content knowledge including depth, breadth of concept.

Prospective biology teachers’ PCK is important in this research because in order to study how teachers translate their understanding of Education for Sustainable Development, it is crucial to find out how they have interpreted their understanding of Education for Sustainable Development, found different ways of representing it through classroom activities and adapted their understanding to take into account their student’s ability, age and prior knowledge [10].

Explanation and discussion must be given to them before making teaching learning plan because of the Education for Sustainable Development concept is complex [11]. It is expected that prospective biology teachers have interpreted their understanding of Education for Sustainable Development into PCK to be able to effectively teach the respiratory system. Based on the components of Education for Sustainable Development, namely economic, social and environmental perspectives [12] are found in the understanding of prospective teachers A and B and have been seen using all three simultaneously which means sustainability. Similarly, they can provide examples of issues related Sustainable Development targets.

Understanding of Education for Sustainable Development turns out to translate differences into teacher PCK. Specific topic Respiratory system learning conducted by prospective A and B biology teachers can support of SDGs. Learning by teacher A and B aligns with the achievement of goals of Sustainable Development of 3rd namely good health and well being (social perspective), 8th namely decent work and economic growth (economy perspective) and 15th namely life on land (environment perspective).

4. Conclusion
Prospective biology of teachers A and B show the ability to learn respiration systems based on their understanding concept of Education for Sustainable Development. This can be seen in their PCK, 6 component shown namely aspect Sustainable Development that there is a perspective on economic, social and environment which simultaneously and harmoniously leads to the sustainability of present and future life, especially those related to the respiratory system; material in curriculum, context / issues, learning strategy, evaluations and outcomes. However, despite having an understanding of Sustainable Development, it produces a different PCK. According to teaching and learning plan, they made a great equation and concepts in the idea, namely structure and function of organs, respiratory mechanisms, disorders and diseases. As for the differences in context / issues, learning strategy, evaluations and outcomes. What's interesting about this study is that combining the concepts in the respiratory system with a sustainable concept, they both use the lungs disorders and diseases to the presence of smoke, although with a focus on different issues namely cigarette smoke and smoke from the smoking fish process, thus showing a different PCK. Learning by teacher A and B aligns with the achievement of goals of Sustainable Development of 3rd namely good health and well being (social perspective), 8th namely decent work and economic growth (economy perspective) and 15th namely life on land (environment perspective).

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