USEJ 7 (3) (2018)

Unnes Science Education Journal

http://journal.unnes.ac.id/sju/index.php/usej

SUSTAINABILITY IN THE FRAMEWORK OF PEDAGOGY CONTENT KNOWLEDGE FOR PROSPECTIVE TEACHER IN TEACHING THE MATERIALS OF FEMALE REPRODUCTIVE SYSTEM TO IMPROVE STUDENTS' SCIENCE LITERACY

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Article Info

Article History:
Accepted July 2018
Approved November 2018
Published December 2018

Keywords:
Contextual; Integrated Science; Modules.

Abstract

This study aims to determine the effect of the sustainability concept in the framework of prospective teachers on female reproductive system materials to improve the ability of students' science literacy. The study used two classes which are selected randomly as an experimental class, in one of the local high school in Grobogan District. Biology teacher candidates integrate the three aspects of sustainability those are socio-cultural, economic, and environmental in PCK as seen in the CoRe document, learning tools and female reproductive system as learning's material. Students have to answer science literacy questions before and after learning session. Science literacy abilities use level 1 to level 3. The answer scores consist of three assessment criteria, namely "full credit" = score 3, "partial credit" = scores 1 and 2, and "no credit" = 0. This study shows that the context of sustainability in prospective teacher PCKs on female reproductive system materials can increase the average score of the students. In line with the higher level of abilities will lead to a higher percentage in full credit achievement. However, the higher level of achievement still results in lower full credit.

p-ISSN 2252-6617
e-ISSN 252-6232

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INTRODUCTION

A teacher has vital and strategic roles in education. A teacher is a leader who monitors and handles all teaching and learning process in the school. Thus, teachers should have excellent competencies in executing their professional task as the agent of teaching (Law no.14/2005). Their professionalism comes from how the teacher manages the class. The responsibility of class management is not only limited on making students know things but also making them as an educated human being for themselves and their surrounding (Novauli, 2015).

How teacher teaches specific materials needs Pedagogy Content Knowledge (Shulman, 1986). Liu (2013) states that the integration of PCK to the teaching process is an integral part of teacher professional development. **Tabel**

In more than 20 years, many researchers have researched the adaptation of the idea of PCK as the teacher's guide. PCK continuously develops for the sake of building a teacher's pedagogic knowledge and content. Specifically, content is the learning subject, while pedagogy means the processes, strategies, procedures, and steps of teaching and learning (Jimoyiannis, 2010). Meanwhile, Mishra dan Koehler (2009) state that Pedagogical Knowledge is the way and process of teaching which includes the knowledge of class management, tasks, learning preparation, and students' learning process.

Most knowledge on the concept of PCK has developed the substance of PCK through some researches at the end of the 1980s. Table 1 portrays some of these researches as follows (Schmelzing, 2013).

Table 1. Component of knowledge in the realization of PCK

Reference/ Component of PCK	A	B	C	D	E	F	G	H	I
Shulman (1986)	√	√							
Cochran, King & De Ruiter (1993)	√						√	√	√
Fernandez-Balboa & Stiehl (1995)	√	√	√				√	√	
Hashweh (2005)	√	√	√	√	√		√	√	√
Loughran *et al.* (2006)	√	√	√				√	√	√
Schmelzing *et.al.* (2010)	√	√	√	√	√		√	√	√

Notes :

A. Student learning and conceptions
B. Representations and Strategies
C. Goals and Purposes
D. Curriculum
E. Evaluation and assessment
F. Media
G. Subject matter
H. Context
I. General pedagogy

In Table 1, PCK has the main components of content and pedagogy. The concept also covers internal and external knowledge. The internal sources include the self-reflection from teaching experience, the feeling of the teacher, students, and other teachers; the external sources are the learning materials, the regulation from the government, school's policy, etc.

PCK covers the ability of the teacher in adapting to relevant topics for class instruction (Shulman, 1986). Cochran *et al.*, (1993) states that PCK also copes on what can be done in the learning of a difficult or easy concept for students coming from different age group and background who have conception and misconception in learning. Schmelzing *et al*. (2013) opine that the concept of PCT divides three cognitive dimensions, among others (1) components, (2) types, and (3) topics. In this view, PCK refers to a topic which involves concepts, problems, and issues in Figure 2 as follows.

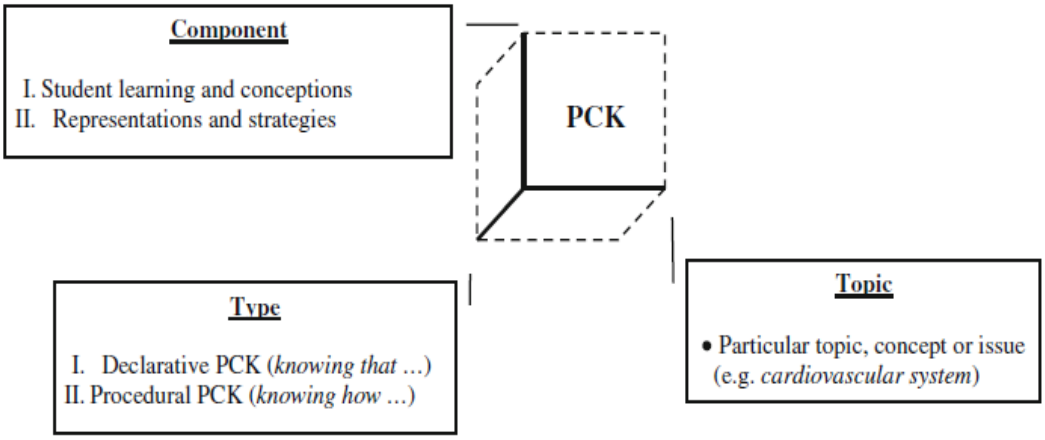

Figure 2. The conceptualisation of PCK (Schimelzing, 2010)

In regards to content, the Ministry f Education and Culture (2016) regulates that each subject should contain the competence and context which covers Sustainable Development Goals, Living Environment, and Quality of Life. Based on the explanation above, PCK should also engage with the component of sustainability that the implementation of teaching biology is integrated into a sustainable environment.

Sustainability is a concept introduced in 1987 on the report of the World Commission on Environment and Development or Brundtland Report by the United Nations (Darwish *et al.*, 2010). Sustainability has a correlation with the environment, economy, and social life for future generation. Kuhlman & Farrington (2010) also state that the concept of sustainability discusses three essential dimensions of environment, social, and economy which are called the triple bottom line. The triple bottom line is related to the profit, planet, and people. These three components should work in balance since they help each other (Kuhlman & Farrington, 2010).

UNESCO (2005, 2012) and Suprastowo *at al.* (2010) say that sustainable development can happen with the development of education since education is the tool of changing perception, behaviour, and human. All the aspects of intellectual in education synergise the aspects of an economy, socio-culture, and environment in managing and utilising natural resources.

The application of the concept can happen in formal education. In the teaching of sustainability, a teacher plays the role of teaching in the context of shaping students' mindset for long-term effect. Sustainability in learning in education is to educate with meaningful, functional, and useful vision for: (1) the development with significant impacts for the current and future generation, (2) improving the quality of human life with the support of the ecosystem, and (3) gaining profit for all humanity in the present and the future (Suprastowo *at al.,* 2010). The National Ministry of Education places education for Sustainable Development as a paradigm of education in Indonesia. That is to say; education produces wellbeing human for the blessing of the universe. These humans are going to fulfil the necessity of current and future life (Priyanto *et al*. 2013).

In the other hand, the survey of PISA in 2012 shows that the science literacy of Indonesian students was in the low level which is unable to make them relate on what they learn to their daily life (OECD, 2014b). In other words, Indonesian students are still unable to relate the content they have learned to the context of the real world. According to PISA, these problems come from the curriculum, teaching process, and assessment procedures which profoundly concerns only on the dimension of content and forgets the dimension of science process and context (Firman, 2007). Science literacy is essential for students to know how they can understand the environment, health

issues, economic problems, and relevant issues in modern life which is related to technology and the advancement of technology.

Based on the background above, there should be an improvement of students' literacy skills after learning the concept of sustainability in the framework of PCK for the prospective teacher of biology in the content of a female reproductive system.

METHODS

This research started with the preparation of the teacher to make a lesson plan for the content of the female reproductive system by writing Content Representation (CoRe) (Loughran *et al.*, 2012). After that, the teacher set the learning utilities which covers sustainability, including the syllabus, Lesson Plan, Students' worksheet, and learning materials in relevance to sustainability in the topic above.

The concept of sustainability in the framework of PCK on the material of the female reproductive system is related to the use of sensitive issues for woman; for instance, the danger of using one-time sanitary napkins as the lifestyle of teenagers to adult women (aspects of sociocultural), practical but costly use of one-time sanitary napkins (aspects of economy), and the trash of napkins which causes environmental problem (aspects of environment) in an article and student worksheet. These issues can be implemented in the learning process following the syntax of problem-based learning. The learning process covers the understanding of human organ, the function of the female reproductive organ, the mechanism of menstruation and fertilisation, and the problem-solving in the sociocultural, economic, and environmental aspects. The learning tools will be executed to a Public Senior High School in Grobogan.

This research is experimental research with one experimental group consists of 2 classes, which are XI MIPA 3 and XI MIPA 4 in a random choice. These classes had a teaching session of the female reproductive system with science literacy assignment at the beginning (pretest) and the end of the session (posttest).

Science literacy test item in 2012 PISA's framework is an essay question which covers level 1 to 3, as follows. Level 3, students can identify clearly and explain scientific issues in a relevant context. Students can choose facts and knowledge to explain natural phenomena and implement simple strategies for an investigation. Students in this level can interpret and use a scientific concept from various scientific concept and apply it directly. Students can develop a simple question using facts and make a conclusion based on scientific understanding.

Level 2, students have an adequate level of scientific understanding in the given context based on a simple investigation. Students can use direct reasoning and make literal interpretation from scientific investigation or technological solution.

Level 1, students have limited scientific knowledge to apply. They can only use that in a limited situation. Students can explain natural phenomena from a specific source.

The instruments of the test in this research is the instruments validated by experts to measure students' literacy level. Students' test were examined manually one by one. The scoring of the test used three criteria of scoring which are full credit, partial credit, and no credit. The full credit is 3 for a perfect answer. Partial credit is for correct answer with incomplete explanation in the number of 1 or 2.

Meanwhile, no credit is 0 for no answer or wrong answer. The achievement of the score is categorised again as very high, high, medium, low, and very low. The achievement can be seen in Table 2.

Table 2. The Category of full credit achievement for students' literacy skills

Success Rate (%)	Category
81 - 90%	Very High
61 - 80%	High
41 - 60 %	Medium
21 - 40%	Low
0 - 20%	Very Low

Source: (Arikunto, 2007)

The result of the test used the score of the pretest and posttest analysing the science literacy improvement on a normalised gain (N-gain). After that, the test was measured using t-dependent to know the different significance of two correlated samples. There is also a t-independent test for knowing the significant difference of both experiment class. The analysis of the data used SPSS version 22.

Table 3. The average pretest and posttest score as well as the N-gain of students' science literacy

Class	Average			Categories
	Pretest	Posttest	N-gain	
XI IPA 3	75	88	0.52	Medium
XI IPA 4	78	86	0.48	Medium

RESULTS AND DISCUSSION

In this research, the pretest and posttest score was obtained to be analysed. The average pretest and posttest, as well as the N-gain score, can be seen in Table 3 as follows.

Based on Table 3, both of the experiment class shows the same improvement from pretest to posttest which is in the medium category. Based on the paired sample t-test (t- dependent), the pretest and posttest of both classes had a significant difference ($p<0.05$). To know whether both classes had the same treatment and give the same average score of science literacy in the posttest, the researcher administered t-independent sample test. The test showed that the average score of the students had no significant difference ($p>0.05$). In more detail analysis, the achievement of the full credit is portrayed in Table 4.

Table 4. The achievement of full credit in each level

Classes	The Achievement of Full Credit in Each Level					
	Pretest			Posttest		
	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
XI IPA 3	91.9%	29.7%	13.5%	97.3%	75.7%	43.2%
XI IPA 4	88.6%	25.7%	2.9%	94.3%	71.4%	45.7%

The achievement of full credit in each level can be seen in each category as in Table 5. Table 4 and 5 show that there was an improvement of full credit achievement on each level of science literacy on both classes, however, the higher the level, the lower the members of the level group.

Table 5. The categories of full credit achievement

Classes	The Categories of Full Credit Achievement					
	Pretest			Posttest		
	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
XI IPA 3	Very High	Low	Very Low	Very High	High	Medium
XI IPA 4	Very High	Low	Very Low	Very High	High	Medium

Based on the explanation above, the content of sustainability in the learning process aims to solve social problems. The three bottom lines of sustainability are integrated genuinely providing understanding on the local and global issues. The metacognitive knowledge requires the students to act and behave for (1) the development with significant impacts for the current and future generation, (2) improving the quality of human life with the support of the ecosystem, and (3) gaining profit for all human in the present and the future. The understanding of sustainability can improve the understanding of the students of the environment.

The literacy of science has a definition to use science, scientific questioning skills, taking a conclusion, and identifying shreds of evidence to communicate the aspects of science (OECD, 2014a). Literacy helps the students to improve their cognitive and affective aspects. The cognitive aspect is related to students' intellectual and their capacity to use their intellectuality effectively. The aspect includes the use of cognitive aspects of the personal, social, and global side. The compelling aspect is related to a problem with science which can help the students to solve a current global issue and in the future (PISA, 2010). The literacy of science is an important thing to be mastered by individuals since it is imperative for people to understand the problems faced by modern society. The modern problem is highly dependent on the development of advanced
science and technological development as a social problem (Kurnia *et al.*, 2014).

Bybee (2009) divides the dimension of science literacy into three parts, which are: content (science knowledge), process (science competence), and context (science application). First, the dimension of content, science content refers to the fundamental concepts of science which is required to understand natural phenomena and to know the changes which nature does to the activity of the human. Second, the dimension of the process copes the competencies in science. The three focuses on the process are: identifying scientific questions, explaining scientific phenomena, and using scientific evidence. Third, the dimension of context is related to the use of science in a personal, social, and global setting, like in health, natural resources, quality of the environment, and the danger and development of modern science and technology.

Based on the explanation above, it can be said that there is a similar concept on the sustainability in PCK with the literacy of science which is in (1) the domain of content, context, and process, (2) the competence of behavior, knowledge, and skills, (3) the scope of environment, health, economy, and other problems in personal, local, and global area, and (4) the value of how the students understand the environment, the development of technology, and the other problems faced by society.

The result of the research also shows the concept of the sustainability in PCK where teacher facilitates the students of XI IPA 4 and XI IPA 3 to grow their curiosity, thinking skills, science processing skills, environmental

awareness, and the sustainable management. The use of sustainability can improve the overall understanding of the students (Rizqiyah & Hartadiyati, 2017). Riyanti *et al.* (2017) show that the use of sustainability in learning can improve students' critical thinking skills. In the learning process, the influencing factors from the teacher to the outcome are the struggles, personal aspects, social aspects, and working habit (Astuti *et al.*, 2012). This thing is affirmed by Abbel (2009) that the score of PCK is what is called learning and teaching science which influence how to learn science.

Sustainability in PCK is included in the learning utilities, including the Syllabus, Lesson Plan, Student Worksheet, and Learning Materials which can ignite students' cognitive minds. The sustainability of female reproductives is related to the sociocultural, economic, and the environment starting from level 1 to level 3. However, this research shows that the improvement of the pretest to posttest is still in a medium level where the more difficult the test item, the lower the students to excel. The result is caused by students who are not familiar in doing science literacy test or test which use interdisciplinary and complicated way of thinking, that the students should be trained more in learning or doing the tasks.

CONCLUSION

This research concludes that the concept of sustainability in PCK on the material of the female reproductive system can improve students' science literacy skills on medium level. The tendency is that the higher the level of the test, the lower the achievement of the full credit. The recommendations to follow up this research are:

1. The concept of sustainability in PCK requires a teacher who has a strong understanding of the concept of sustainability.
2. The concept of sustainability in PCK requires a teacher who is creative and innovative in using local and global issues in the classroom.
3. The concept of sustainability in PCK requires a teacher who is creative in setting their teaching equipment and how to implement it in the classroom.
4. The concept of sustainability in PCK can become an alternative to improve students' science literacy.
5. The concept of sustainability in PCK can become an alternative to improve teacher's professionalism.

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