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Submission date: 02-Mar-2022 11:37AM (UTC+0700)
Submission ID: 1774419597
File name: eai.12-10-2019.2296475.pdf (188.91K)
Word count: 3407
Character count: 19189

Pedagogical Content Knowledge Ability in Reflecting Project-Based Learning on Physics Concepts

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Abstract. Pedagogical Content Knowledge (PCK) is the ability to teach content on a particular concept so students can master the concept correctly. One characteristic of a qualified teacher is having excellent PCK ability. The purpose of this study is to obtain a PCK ability profile of prospective physics teachers in reflecting project-based learning (PjBL) that had been carried out. This research is qualitative research with a narrative research design. The data collection instrument in this study is Pedagogical and Professional-experience Repertoires (PaP-eRs). The subjects in this study are 13 physics students (prospective teachers) in one of State University of East Kalimantan. The results show that the average value of PCK ability of prospective physics teachers in reflecting PjBL is 50% insufficient category. Therefore, academics or stakeholders need to add adequate facilities as a means for students to practice teaching, develop teaching materials, and master the concept of physics better.

Keywords: Pedagogic, Project Based Learning, Physics Concept

1 Introduction

The results obtained by Indonesian students in the TIMSS (Trends in International Student Assessment) study and the Program for International Student Assessment (PISA) from 1999 to 2015 showed that the achievements of Indonesian children were still ranked lower in several reports issued. This shows the need for changes in the learning process which has been more focused on teacher-centered learning and only focuses on cognitive aspects. There are 4 skills in the 21st century that students can apply to everyday life. These skills are known as 4C skills (creative, critical thinking, communicative, and collaborative), so student-centered learning becomes a necessity in facing world challenges. One learning model that can be used is the Project Based Learning (PjBL) model. Several studies have shown the success of applying the PjBL Model in improving student achievement [1,2,3,4] makes it easier for students to connect existing problems with real-life [5], develop students' soft skills [6], and form communities [7].

Professional and quality teachers in their fields are needed to be able to apply the PjBL Model well so students can get the maximum benefit from learning. Teachers often do not realize that pedagogical aspects and actions supported by the knowledge base are very important in supporting professionalism as teachers [8] and making them qualified teachers [9]. Shulman [10] introduces pedagogical content knowledge (PCK) that combines pedagogics and content. Loughran, Milroy, Berry, Gunstone, and Mulhall [11] developed an approach that could

MSCEIS 2019, October 12, Bandung, Indonesia

DOI 10.4108/eai.12-10-2019.2296475

describe the ability of PCK known as CoRe (Content Representation) - which represents the particular content / topic of the science teaching - and PaP-eRs (Pedagogical and Professional experience Repertoire) and help offer insights into the pedagogical content knowledge itself.

Loughran [12] states that for teachers, making PaP-eRs is a challenge and they like reading and re-analyzing the PaP-eRs they have made. Thus, by making PaP-eRs encourage them to reflect on learning and as a means of sharing teaching experiences between fellow teachers about learning and teaching. Reflections on learning through PaP-eRs can be used to make changes or improvements in their teaching practices [13]. The author assumes that it is important for students (prospective teachers) of physics to be trained to reflect on learning activities through the creation of PaP-eRs to have good PCK skills so that they become qualified teachers. Based on these matters, the authors are interested in conducting preliminary research which aims to obtain an overview and analyze the ability of the Pedagogical Content Knowledge (PCK) of students (prospective teachers) to reflect PjBL activities on the concept of physics.

2 Experimental Method

This research is qualitative research with narrative research design [14] which is carried out to analyze or describe the ability of PCK students (prospective teachers) to reflect on Project Based Learning activities on physics concepts. The subjects in this study are 13 physics students (prospective teachers) in one of State University of East Kalimantan who implemented the Field Experience Program (PPL) in Samarinda High School by applying the Project-Based Learning model in teaching physics material. The data collection techniques used were questionnaires and interview techniques. The research instrument used was PaP-eRs (Pedagogical and Professional experience Repertoire).

3 Result and Discussion

In this section, the results of the study will include a profile or a description of the PCK abilities of prospective physics teachers in reflecting on learning using the PjBL Model. This description is obtained through the PaP-eRs instrument made by prospective physics teachers after carrying out classroom learning. PaP-eRs broadly includes narratives of apperception and motivation as well as cognitive conflict, core activity narratives in learning, closing activity narratives, reflection on assessment activities, and reasons for using the PjBL model and the advantages and obstacles in the learning process, which are then broken down into 13 components.

3.1 The PCK ability category (based on percentage) of physics teacher candidates in reflecting the PjBL model

The PaP-eRs format used in this study consisted of 13 components that processed the score to find out the percentage value of the PCK candidates for Physics Teachers through PaP-eRs as a whole and per component of PaP-eRs. The average percentage of PCK prospective Physics Teachers' ability through PaP-eRs as a whole is 50% in the sufficient category. The percentage and complete category of PCK abilities of prospective physics teachers are presented in the following Table 1:

Table 1. PCK Capability Category of Physics Teacher Candidates through PaP-eRs.

PaP-eRs Component	Percentage	Categories
Narrative of apperception and motivation and cognitive conflict	38%	Less
Narrative core activities: Observation / observing activities	38%	Less
Narrative core activities: Activities ask questions	38%	Less
Narrative core activities: Reasoning activities	46%	Enough
Narrative core activities: Try activities	54%	Enough
Narrative core activities: Activities communicating	38%	Less
The closing activity narrative: reflection related to concepts that must be mastered by students	42%	Enough
Narrative closing activities: giving contemporary knowledge or applying concepts to everyday life	46%	Enough
Narrative closing activities: information related to the best individual learning groups	54%	Enough
The closing activity narrative: delivering the material to be learned at the next meeting	54%	Enough
Narrative assessment activities	71%	Well
Reasons for using certain PjBl models and assessment techniques	58%	Enough
Strengths and weaknesses when implementing the PjBL process	71%	Less

Table 1 shows that the highest average percentage of prospective Physics Teachers' PCK per component PaP-eRs is 71% in components 11 and 13, namely in the delivery of assessment activities and the advantages and disadvantages of applying the PjBL Model. The lowest average ability of PCK per component of PaP-eRs is 38%, namely in components 1,2,3, and 6 about narrative of apperception and motivation as well as cognitive conflict, core activities in terms of observing, asking questions, and activities communicate the steps and learning outcomes.

3.2 Document review in terms of PaP-eRs

The following are the results of an overview of the PCK capabilities of prospective physics teachers in reflecting the PjBL that has been applied, outlined based on each component contained in the PaP-eRs:

Based on table 1, in the components of apperception and motivation as well as cognitive conflict, the PCK ability of physics teacher candidates is in the less category. Most of the narratives written are very general, not detailed narratives related to the learning material that has been taught. Based on the narrative made, most of the prospective teachers only narrate the opened learning by saying greetings and checking the attendance of students, most do not convey the learning objectives, do not explain the models that will be used in the learning process, initial information about the learning material delivered by prospective physics teachers can't construct cognitive conflict related to the project-based learning activities that they will carry out. At this stage, there is only one candidate for a physics teacher who narrates the

activities that give rise to cognitive conflicts related to the material being taught. Here is her narrative for example:

"In this preliminary activity lasts for 10-15 minutes whereafter checking the presence of students, the teacher provides motivation and apperception in the form of an approach by showing phenomena that occur in daily life about physical material that is widely used by the community and the tools around their lives. Students are given a picture of a bowling ball, a game on a billiard ball and an event in the form of a collision that occurred on two cars. From the three pictures, the teacher gives questions that are part of the apperception, namely: "What is experienced by billiard balls, bowling balls and events that occur in the car?". These three pictures show students about one of the examples of collisions that will be discussed in the next material and entice students to learn material momentum and impulses. After the questions are given, the teacher allows students to answer what is happening or provides an explanation of the three pictures to attract students' attention and observe whether students understand the problems given. The teacher listens to the answers given to students to see the responses of students and the ability to understand the problems given. After hearing the students' answers the teacher conveys the learning objectives to be achieved at this meeting"

Narrative core activities include observing, asking questions, reasoning, trying, and communicating. Most of the physics teacher candidates only narrate observing and questioning activities done at the beginning of learning, for example, narratives that show videos related to physical phenomena, then students observe the video, and ask questions related to physical material related to the video. In fact, by applying the PjBL Model the teacher has more opportunities to develop the ability to observe and ask students, not only at the beginning of learning, but observing this activity can also be carried out throughout the learning process and making their physics project, therefore the ability of PCK teacher candidates physics in this aspect is in the less category as presented in table 1. The narrative of reasoning activities by students written by physics teachers in the PjBL activities includes appearing at the beginning of learning when students reason making hypotheses over observed physical phenomena, reasoning about what tools and materials are needed to make a project, reasoning how to complete the project by facing problems during the process of making projects and other things. Narrative activities try to be written by prospective physics teachers in terms of making a project, and carrying out the duties of each group member in the project work, trying to test their project before being presented in front of the class. The ability of PCK physics teacher candidates in these two aspects (reasoning and trying) is insufficient categories, while in the narrative the activities of communicating are in the less category. Narrative communicating activities made by prospective physics teachers only appear at the end of learning.

The narrative of the closing activities made by physics teacher candidates is included in the fairly good category. The narrative is in the form of the teacher's activity to notify students of the physics material to be studied at the next meeting, then the teacher gives a reflection regarding the physics concepts that have been studied, as well as the appreciation given by physics teacher candidates to groups or individuals who can complete the best physics project assignments. In addition to these matters, ideally, the closing activities do not only contain reflections on physics material but also need a pedagogical reflection that is a reflection of the learning process that has been carried out by students and teachers. The results of the reflection of physical and pedagogical material in the learning process can be an evaluation or improvement material so that the learning process that follows can run better. In the PaP-eRs made by prospective physics teachers, there is no narrative about how they together with students reflect the PjBL activities that have been carried out, there is no narrative how they find

out student responses related to the model, whether students consciously obtain and feel the benefits of making activities physics project with their friends.

Reflection narratives made by physics teacher candidates in the assessment activities are one of the components of the PaP-eRs which get the highest percentage (based on table 1). In this component, the narrative made by the physics teacher candidate is in the form of assessment techniques used. All prospective physics teachers use performance assessments in the form of evaluating the process and results of physics projects that have been made by students. In the narrative, only a few prospective physics teachers also explained about assessment rubrics and how physics teacher candidates process student scores.

In general, the narrative about the reasons for prospective physics teachers using the PjBL model contains the usefulness of applying the PjBL model to students. For example, the following narrative was made by one of the physics teacher candidates in this component, "The reason I did the learning as explained where I used the Project Based Learning (PjBL) model was first, to provide experience in the physics learning process which takes place in schools so that it can leave a meaningful impression if the students do with their own hands the projects they make, such as how to make a project that is not easy, there must be some obstacles in the process so students can understand the subject matter with the experiences they get -one. Second, by using the PjBL model students produce a tangible result in the form of a product that can be used as an example in the application of subject matter namely momentum and impulses in real life and daily life that often occur around their environment. Third, another reason is to know and assess problem-solving skills in working on projects, sharpening students' skills in creative thinking, critical thinking, and other thinking skills. The fourth reason is to create a different learning atmosphere where students are more active in learning than teachers (centered on students where the teacher becomes a facilitator) and so that the teaching and learning process of physics is not boring to create a pleasant and interesting atmosphere."

Model Based on the PaP-eRs that have been made by prospective physics teachers there are many advantages that prospective teachers can obtain through the application of the PjBL model. Prospective physics teachers are easier to narrate the advantages of the PjBL model compared to the shortcomings of this model, as seen from the narrative made by several physics teacher candidates who elaborate on the advantages of the PjBL model but most of the physics teacher candidates do not explain the shortcomings they experienced during the learning process PjBL Model. The advantages of the PjBL model that they obtain include making students more active, more able to understand the application of physics in everyday life, motivating and increasing students' interest to learn more about physics, as a variation in the learning process, and many other advantages.

Based on the data and review of the PaP-eRs document, the ability of prospective physics teachers to reflect PjBL activities is only in a fairly good category, this is thought to be because prospective physics teachers do not have much experience in teaching, especially teaching using the PjBL model. Through interviews with students (prospective teachers) of physics, they argued that at first, they thought teaching was an easy thing if they had mastered the physics material that would be taught well. Activities to make PaP-eRs greatly help those who are still minimal in teaching experience to reflect learning activities. By writing and rereading the PaP-eRs that they have made, it makes it easier for them to know their shortcomings when teaching, understand that teaching is not just about delivering physical material but also has to be able to adjust teaching methods to different student characteristics, so they can improve the next learning process. This is in line with the research conducted by Bertram [15] which states that CoRes and PaP-eRs can be explicitly instances of PCK for the beginning of the science teacher

but more importantly they help to highlight and build knowledge of teaching and learning about science in new ways that extends beyond normal beginning teacher thinking.

Besides, by writing and rereading the PaP-eRs that they make, physics teacher candidates realize that teaching is not only in terms of mastering content but how students learn, so the ability to integrate content and pedagogics is needed. The ability to integrate content and pedagogics does not come out of nowhere, these abilities are born and develop from time to time if the teacher always learns and reflects on the activities/teaching experiences they have done. This is in line with the opinion of Loughran [12] which states that teaching is not a simple matter but a complex matter and will develop over time in line with their experience in teaching in real conditions, therefore, Based on the results of study, academics or stakeholders need to add adequate facilities to students to develop teaching materials, the master concept of physics better and practice teaching to enrich their experience in teaching.

4 Conclusion

Based on the data and results of the study of student PaP-eRs documents (prospective physics teachers) at one of the state universities in East Kalimantan, the average percentage of PCK's ability to reflect Project-based Learning (PjBL) activities of 50% was in a fairly good category. The highest average percentage of prospective Physics Teachers' PCK per component PaP-eRs is 71% in the good category, namely the narrative in the assessment activities and the narrative of the advantages and disadvantages of applying the PjBL Model. The lowest average percentage of PCK capabilities per component of PaP-eRs for physics teacher candidates is 38% is in the poor category, namely in the narrative of apperception and motivation as well as cognitive conflict, core activities in terms of observing, asking questions, and communicating steps and learning outcomes.

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