Student pedagogical content knowledge through project based learning models

T S Sumartini*, D V Rahayu, M A Noordiana, I P Lurytawati and D Mardiani

Institut Pendidikan Indonesia, Garut, Indonesia

*Corresponding author's email: tina.srisumartini@gmail.com

Abstract. Lack of Pedagogical Content Knowledge (PCK) of a teacher becomes a problem in the implementation of mathematics learning. Therefore, it is necessary to make appropriate efforts in developing PCK among students as a form of formal education and as a provision for teaching in the future. One effort that can be done is the use of Project Based Learning (PBL) models. This study uses a quantitative method with the quasi-experimental design (the pretest-posttest non-equivalent group design). The sample used was students of mathematics education study program at the Institut Pendidikan Indonesia (IPI) Garut. The results of the study show that student PCK as a prospective mathematics teacher who gets a PBL model is better than students who get conventional learning models. In addition, the development of PCK needs to be accompanied by the development of knowledge of mathematical content as a whole of the teacher's competence in teaching mathematics.

1. Introduction

Success in education needs to be supported by a quality management system and competent teachers so that they can educate students to become quality and civilized people. Teachers and lecturers must have four competencies, namely: pedagogic, personal, professional, and social competencies. One of the important competencies possessed by teachers is pedagogic competence. This competence relates to the ability to manage student learning which includes an understanding of students, designing and implementing learning, evaluating learning outcomes and developing students to actualize their various potentials.

Another term for pedagogical competence is Pedagogical Content Knowledge (PCK). In mathematics learning, pedagogic competence plays a role in helping students understand the mathematical material [1] states that PCK consists of three characteristics, namely: Knowledge of Content and Student (KCS), Knowledge of Content and Teaching (KCT), and Knowledge of Curriculum (KC). KCS is related to the teacher's ability to anticipate the way students interact with concepts. Each student has a different way of responding to mathematical content. Therefore, the teacher needs to predict the way students think about the content being studied and know and analyse the misconceptions that occur in students in learning mathematics material. KCT relates to the teacher's ability to present mathematical content comprehensively. Presentation of material needs to be carefully prepared to determine the right representation, method, and procedure so that the learning process is interwoven optimally. KC is related to the teacher's ability to understand the curriculum that is in force. Education is inseparable from government regulations in managing education. Therefore, teachers need to adjust the curriculum that is being applied to the learning process that is being experienced. In this case, the development of students' abilities becomes important in educational goals.

Development of PCK to students as prospective mathematics teachers needs to be accompanied by the right learning model. One of the right learning models is the Project Based Learning (PBL) model. This learning model uses the project as a form of learning achievement that has been done. The phase-in PBL in [2] consists of *start with the essential question*, *design a plan for the project, create a schedule*, *monitor the students and progress of the project*, and *evaluate the experience.*

PBL is a learning that involves focusing on meaningful questions and problems, problem-solving, decision making, the process of finding various sources, giving members the opportunity to work collaboratively, and closing with real product presentations [3]. Projects in PBL need to have five criteria: centrality, driving questions, constructive, autonomous, and realistic investigations [3]. Centrality means that projects PBL are central to learning. In this case, students learn the concept through making projects. Driving questions means that projects in project-based learning are focused on questions or problems that encourage students to arrive at the expected concept. Constructive investigation means that projects in PBL must involve students in investigations and develop constructive knowledge. Projects are autonomous, meaning students have more authority in project implementation and without direct supervision from lecturers. Students determine their own time to be used for project implementation. Projects must be realistic, meaning that the project has authenticity and challenges that connect concepts with the real world.

The project produced in this study, namely mathematics teaching materials. Through the creation of this teaching material, students are expected to be able to anticipate various conditions in mathematics learning that involve students, curriculum, and how to teach. Based on this, the purpose of this study was to determine the achievement and interpretation of the increase in student PCK who received PBL and conventional.

2. Methods

This study uses a quantitative method with the quasi-experimental design (The Pre-test Post-test Non-Equivalent Group Design) [4] as shown on Figure 1:

Experiment	O	X	O
	- - - - - - - - - -		
Control	O		O

Figure 1. The Pre-test Post-test Non-Equivalent Group Design

The population in this study were all students majoring in mathematics education at the Institut Pendidikan Indonesia (IPI) Garut. The sampling technique was carried out by purposive sampling technique by taking two classes, each of which was given a conventional project-based learning model. The study was conducted at the Department of Mathematics Education of IPI Garut in the subject of Kapita Selekta Matematika Sekolah Menengah Atas. Data collection was done by giving PCK questions in the form of pretest and posttest. From the results of the test, the pre-test and post-test data were obtained, the results of which were processed using the Mann Whitney test because the posttest data in both classes were not normally distributed. To see the improvement PCK using the normalized gain formula namely:

$$g = \frac{\text{skor postes} - \text{Skor pretes}}{\text{Skor ideal} - \text{Skor pretes}} \quad (1)$$

The results of the calculation of normalized gain scores can be interpreted in three categories, namely (Table 1):

Table 1. N-Gain Interpretation

N-Gain (g)	Interpretation
$g \geq 0.7$	High
$0{,}3 \leq g < 0.7$	Medium
$g < 0.3$	Low

3. Results and Discussion

The purpose of this study is to find out how the achievement of student PCK that get a PBL method compared to conventional learning models. Descriptive data of research results can be seen in the following Table 2:

Table 2. Average and Standard Deviation of PBL and Conventional Classes

	PBL		Conventional	
	$\bar{x}$	s	$\bar{x}$	s
Pre-test	2.10	0.73	1.94	0.85
Post-test	3.08	0.32	2.59	0.44
N-gain	0.43	0.30	0.31	0.08

Based on the results descriptively it was concluded that the average PCK posttest of students who received PBL was higher than conventional classes.

Furthermore, inferential calculations are carried out from the posttest data used to see the achievement of student PCK after learning. Before further testing is carried out, the data normality calculation is done first; the results can be seen in the following Table 3:

Table 3. Normality Test Results

	Statistic	df	Sig.
PBL	0.925	31	0.032
Conventional	0.827	31	0.000

Based on table 3, it can be concluded that PCK post-test data in both classes are not normally distributed with a significant level of 0.05. Because the two classes are not normally distributed, the Mann Whitney test is continued. The results can be seen in Table 4 below:

Table 4. Mann Whitney Test Results

	PCK
Mann-Whitney U	222.000
Wilcoxon W	718.000
Z	-3.674
Asymp. Sig. (2-tailed)	.000

Based on Table 4, it can be concluded that there are student PCK achievements that get PBL better than conventional. The interpretation of the increase in student PCK can be seen in the average value in table 2, namely the average N-gain of PCK in the PBL class of 0.43 and the average PCK in the conventional class of 0.31. So, it can be concluded that the interpretation of the increase in student PCK in both classes has a medium category.

Mathematics teaching requires the management of complex learning resources, including subject matter and PCK teachers of mathematics subjects themselves. Effective teaching involves the interaction of the teacher with students in understanding the background and experience of students in learning mathematics. Teachers need to form opportunities that allow students to learn meaningfully. In this case, learning involves the experience of students in independent learning and places the teacher as a facilitator. Teacher PCK positively predicts student achievement whose effects are mediated by cognitive activity [5].

Based on the results of the data analysis, it was concluded that the achievement of student PCK who received PBL learning was better than conventional with an interpretation of the improvement of the two classes in the medium category. This indicates that project-based learning has a positive influence on the development of student PCK. At the driving questions stage, students make questions related to the product of teaching materials to be made. The question needs to consider the mathematical content and characteristics of students. Furthermore, students conduct constructive investigations in the form of investigations conducted on students as an effort to answer the questions that have been prepared. In the process, it allows students as prospective mathematics teachers to develop abilities in anticipating various possibilities in the learning process. Indirectly this process in developing student PCK.

The project for making geogebra-based application materials has a positive effect on student PCK. This will certainly affect their teaching practices. Participating in projects provides a substantial change in the teaching practice of prospective teachers [6]. Making teaching material projects allows the teacher to plan the learning process from various things such as student conditions, environment, media, and so on. In addition, PBL has a positive effect on the success of student learning in science subjects [7]. PBL needs to be developed as an alternative learning model that will develop cognitive and affective abilities of students.

The use of geogebra as part of technology needs to be supported by the current curriculum. This is consistent with [6] that the use of technology in education must be applied explicitly in the curriculum. The use of technology in education is a challenge, but a bigger challenge is how technology is used, by whom, and why it is necessary to use technology in mathematics learning. This is certainly a big question for a teacher. A teacher's PCK will be more meaningful if accompanied by technological knowledge. Effective teachers are central to improving the quality of education [1]

Lecturers have the core responsibility to improve content knowledge and student PCK as prospective teachers in mathematics learning. PCK is a form of interaction between conceptual mathematical understanding, teaching experience, and class interaction [6]. A teacher who has a mathematical understanding needs to do experience in teaching in order to know the conditions of mathematics learning and see various possibilities in interacting with students. There are two internal PCK constructs, namely the application of understanding topic to class content and variable consideration of students' understanding of the choice of learning practices [8].

4. Conclusion

Based on the results of the study it can be concluded that the student PCK that gets PBL is better than conventional learning with an interpretation of the improvement of the two classes in the medium category. PCK development for prospective math teacher students needs to pay attention to the knowledge of student content because they are related.

5. References

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