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To cite this article: Slamet Suyanto and Yuni Wibowo 2018 *J. Phys.: Conf. Ser.* **1097** 012042

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# Curriculum Review of Teacher Professional Development Program Based on Biology Teacher Profile in Technological Pedagogical and Content Knowledge

Slamet Suyanto<sup>1,a)</sup>, Yuni Wibowo<sup>2,b)</sup>

<sup>1,2)</sup>State University of Yogyakarta

<sup>a)</sup>[slamet\\_suyanto@uny.ac.id](mailto:slamet_suyanto@uny.ac.id),

<sup>b)</sup>[yuni\\_wibowo@uny.ac.id](mailto:yuni_wibowo@uny.ac.id)

**Abstract.** Teachers in Indonesia must follow Teacher Professional Development Program (PPG) for one year. This article reflects the curriculum of PPG through the TPACK profile of the graduates. TPACK is composed of Pedagogical Knowledge (PK), Content Knowledge (CK), and Technological Knowledge (TK) as proposed by Shulman. This research measured PK, CK, TK and PCK of biology teachers participated in PPG SM3T in the Biology Education Study Program in UNY to reflect on the curriculum of PPG. The respondents were fifteen biology teachers participated in PPG. The instruments were tests constructed based on the test of teacher competences test (UKG) and on the national biology Olympiad tests. The tests were conducted at the end of the program. The results were analyzed using descriptive statistic. The results indicate that PK, CK, and TK of the PPG participant scored 59.3, 52.9, dan 62.7 of scale 100. The results was similar to the results of National Teacher Examination (UKG) where biology teachers scored 62.0. The CK scored 26.2 for material of genetics of the national Olympiad. Therefore, the teacher competences on TPACK still need improvement. The curriculum of PPG that relayed meanly on PK should be adapted to the development of CK and TK.

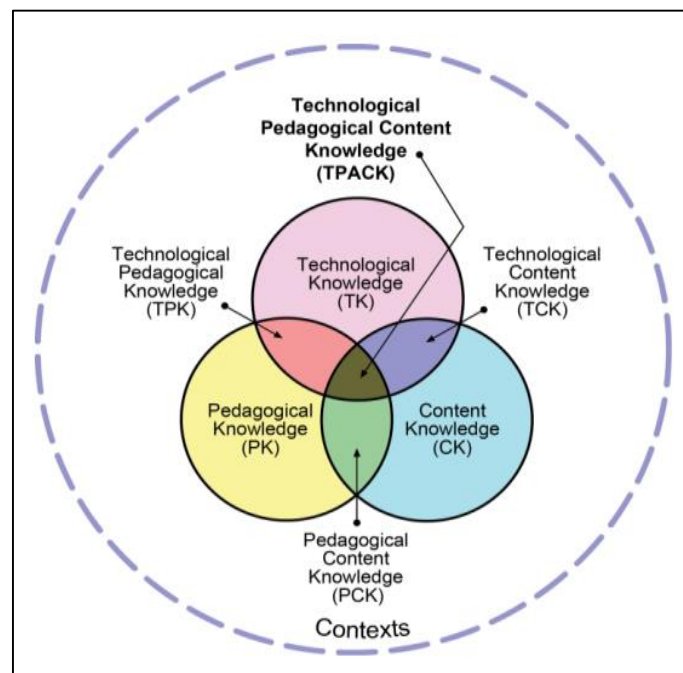
## 1. Introduction

Teacher professional development program in Indonesia has been growing since 1982. It started from SPG (high school), to Diploma II (2 years in college), to undergraduate program (4 years in college), and to teacher professional development program (5 years in college). It is expected that teacher competences increase as the program develops. According to the Teachers and Lecturers Law <sup>1</sup>, teacher competences include four aspects, namely Pedagogic Competence, Professional Competence, Personality Competency, and Social Competency. Those terms of competences are now known as Pedagogical Knowledge (PK), Content Knowledge (CK), and Technological Knowledge (TK). In the learning process, the three sciences interact with each other to build Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), and Technological Content Knowledge (TCK). Therefore, the interaction builds Technological Pedagogical and Content Knowledge (TPACK) as a whole [11]. The mastery of TPACK includes the science, pedagogy, and related technology in certain fields (Vela & Medrano, 2015; [11]; [15]). For biology teachers, TPACK includes abilities in mastering biology, biological science related technologies, biological pedagogy and the combination of those three



elements (Herring, Koehler & Mishra, 2016). Research on biology teachers' TPACK gives an overview of the biology teachers' abilities in the mastery of biology, biology education, and biology education technology. Those three are the competencies that teachers need in learning (Glaser, 1984; Putnam & Borko, 2000; Shulman, 1986, 1987).

Based on history, TPACK has been initiated by Shulman since 1987. Shulman devised taxonomy of teacher knowledge and stated that the content and the pedagogical knowledge and works out the pedagogical content knowledge as the special amalgam of content and pedagogy (Shulman, 1987, p.8). Thus, according to him, the mastery of science and pedagogy forms the specific subject of pedagogy which becomes the unity between knowledge and pedagogy. Shulman (1987) described PCK as subject matter knowledge for teaching. In Indonesia, it is known as the specific subject of pedagogy.



**Figure 1.** The structure of TPACK according to Shulman [11]

TPACK is composed of three main components namely CK, PK, and TK. They form a complex fabric (Mishra, Spiro, & Feltovich, 1996; Spiro & Jehng, 1990), so that seven TPACK components are formed i.e. (1) PK, (2) CK, (3) TK, (4) PCK, (5), TCK, (6) TPK, and (7) TPACK. PK is the science of education or pedagogical knowledge. [11] p.64 state, "Teachers should have deep knowledge about the processes and practices or methods of teaching and learning... This generic form of knowledge applies to understanding how students learn, general classroom management skills, lesson planning, and student assessment". TK is knowledge of technology, tools, methods, and learning resources related to the field of science. [11], p. 65 mentions, "TK is knowledge about certain ways of thinking about, and working with technology, tools and resources, ... including information and communication technology".

PCK is subject specific knowledge that is the science of education tied to the specific knowledge learned [9]; [2]. PCK is a pedagogical ability to teach topics in a particular scientific field. For example, to teach ecosystems to junior high school students, teachers have to master learning methods, student organizations in learning, and instructional media to teach the materials. Shulman (1986) states that teacher must understand the subject being taught, the various ways of teaching it, and how to relate it to the education purposes.

TCK or Technological Content Knowledge (TCK) is the teachers' understanding and ability in using technology related to biology and biology teaching. Related to TCK, based on quotation above, teachers

are demanded to master both the knowledge of the field and the specific technology that can be used to teach the materials. Technological Pedagogical Knowledge (TPK) is “An understanding of how teaching and learning can change when particular technologies are used in particular ways. This includes knowing the pedagogical affordances and constraints of a range of technological tools as they relate to disciplinarily and developmentally appropriate pedagogical designs and strategies” [11], p.65. Therefore, TPK is an understanding on how teaching and learning process can change because of technology application. The way to teach in the teaching and learning process can be different because such a particular technology related to the materials being taught is used.

Technological Pedagogical Content Knowledge (TPACK) is “Underlying truly meaningful and deeply skilled teaching with technology. Instead, TPACK is the basis of effective teaching with technology ....” [11], p. 60. TPACK is a unity of TK, PK, dan CK which is applied by teachers for teaching. Teachers use educational science related to instructional technology to teach the materials and contents constructively. [11], p.61 mentions that TPACK is pedagogical techniques that use technologies in constructive ways to teach content.

Kratz & Schaal (2015) tried to measure PCK of prospective teachers in the United States. He developed an instrument for measuring TPACK. This instrument can be referred for measurement of TPACK. TPACK has a similarity to the cluster of teacher competence, especially the groups of pedagogical competence and professional competence which are similar to pedagogical knowledge and content knowledge.

The results of TPACK mastery research are important for teacher training institute such as UNY to identify the weaknesses and strengths in the teacher education process. Reflection on the results of TPACK of UNY graduates describes the educational insight, knowledge of field of study, and technology mastery, especially education technology on field of study. By knowing the strengths and weaknesses of the graduates in those three aspects, UNY can make improvements in the level of curriculum, learning process, teaching materials, and evaluation of learning. The results showed that the teachers' TPACK ability influences the student learning outcomes. The conclusion is the better the teachers' TPACK ability, the better the students' achievement ([14]; [7]; Hattie, 2009). Other researchers in Germany examined the effect of teachers' TPACK on the success of their students' learning. He found that teachers' ability especially in designing and carrying out learning activities has a significant influence on student learning outcomes. Other research found that primary school teachers were mostly weak in mastering the content and pedagogical content knowledge (CK and PCK) ([14]; [7]; Appleton, 2007).

## 2. Purposes of the Study

The PK, CK, and TK profiles of PPG SM3T participants have never been measured, and this research tries to measure them as a basis to the development of the PPG curriculum. From the description above, the purposes of this study are as follows:

- 2.1 To know the PK, CK, and TK profiles of PPG SM3T participants in Biology Education Department UNY.
- 2.2 To know the CK profile of PPG SM3T participants in high school and Olympiad biology materials.
- 2.3 To give ideas for restructuring the PPG curriculum.

## 3. Research Methodology

### 3.1. Design

This research was a quantitative descriptive research. The purpose of this research was to know the profiles of PK, CK, and TK of teacher professional development program (PPG) SM3T participants. In this study, PPG SM3T participants' insight on PK, CK, TK, and PCK was examined at the end of the year, after they practiced teaching (PPL). After the examination, interview was also conducted to discuss the difficult items of the test. The population was the fifteen participants of PPGSM3T of Biology Education Department at Faculty of Mathematics and Natural Sciences UNY. They were the research census.

### 3.2. Data collection

Data of PK, CK, TK and PCK were collected through the tests. The tests were conducted after the PPGSM3T participants completed the teaching practices (PPL). Thus, it was expected that the participants have completed their teacher professional development program. Participants were asked to do the test and fill in the questions that they knew and could do well. They were not asked to do the tests that they did not understand. Therefore, participants were expected not to guess only.

### 3.3. Instrument

The instrument used was an objective test, develop by using categories developed by Kiray <sup>2</sup>. The test consisted of four parts, namely the CK test for Genetics topic which is equivalent to high school and CK test which is equivalent to national biology Olympiad. Other tests were used to measure PK and TK. There were fifty questions in the test. The questions were taken from national exam questions of teacher competence and national biology Olympiad for high school. The instrument has been validated by expert judgment and empirical validity.

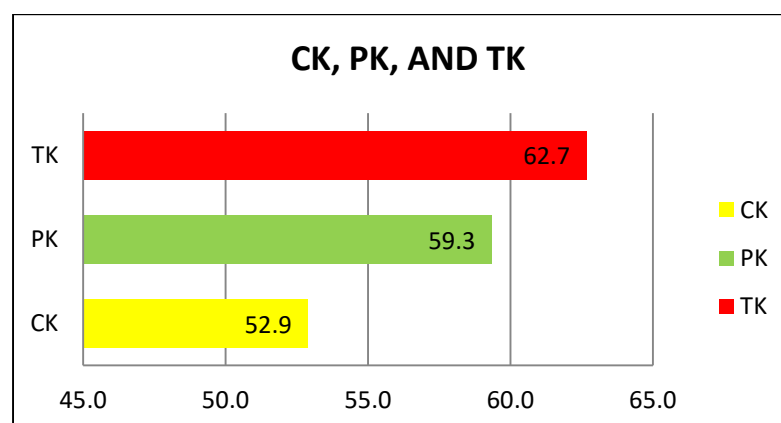
### 3.4. Data analysis

Data of PK, CK, TK and PCK as the test result were analyzed using descriptive quantitative analysis. The data were presented in the form of average table, maximum scores, and minimum scores.

## 4. Result

### 4.1. Profile of PK, CK, and TK

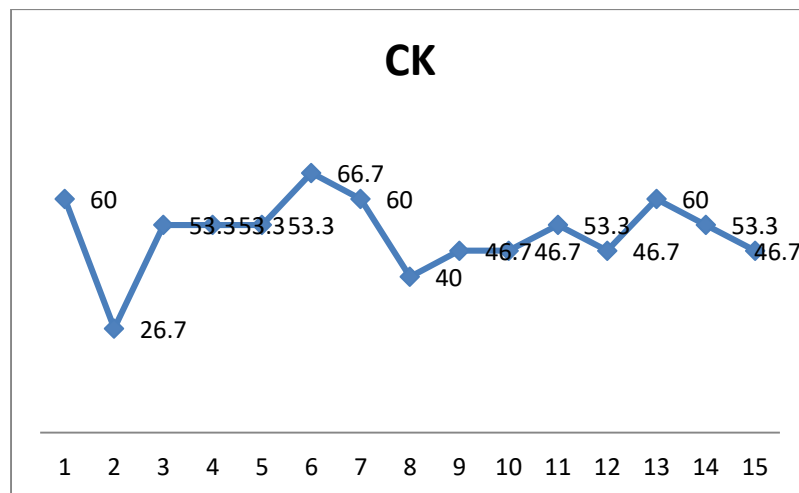
The PPG participants' mastery of PK, CK, and TK was 59.3, 52.9, and 62.7 out of the 100 scale. This finding was quite surprising since the scores were still far from the maximum score. Participants had the highest score in TK which was 62.7. This finding was actually not very much different from the teacher UKG outcomes. The national average teacher UKG outcomes in national level was 56.69 [3]. Based on this, it can be explained that the PPGSM3T program needs to be developed. Results of PK, CK, and TK of PPGSM3T participants are presented in Figure 3.



**Figure 2.** Scores of PK, CK, and TK of PPGSM3T participants in Biology Education Department UNY.

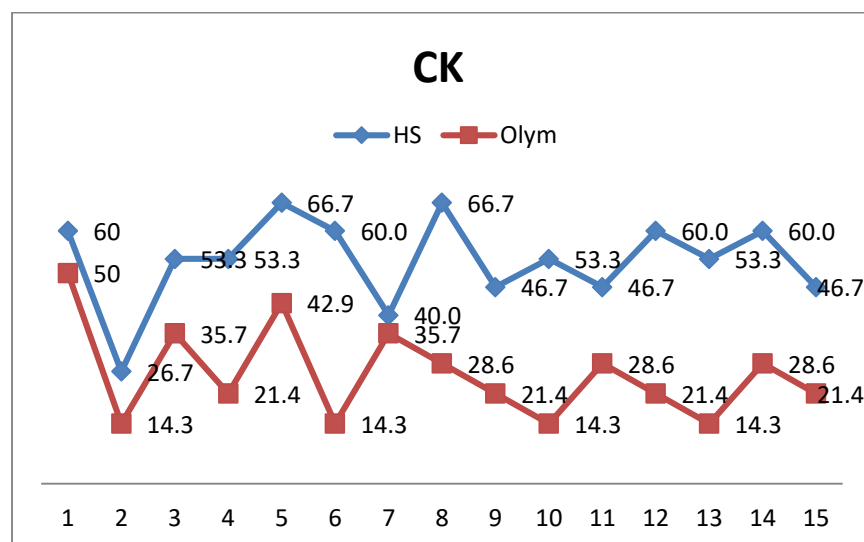
#### 4.2. Content Knowledge

The PPGSM3T participant highest score was 66.7 in a 100 scale on CK for high school biology materials, and the lowest score was 26.7. It meant that the content knowledge of the participants mostly was in medium category (Figure 3).



**Figure 3.** Score of CK of The PPGSM3T participant

The score of the PPGSM3T participant on CK of high school biology Olympiad was lower than it was of high school biology materials (Figure 4). It meant that the participants of PPGSM3T will not ready to assist their students to compete in biology Olympiad.



**Figure 4.** Content Knowledge (CK) profile of the PPGSM3T participant on material of genetics of high school (HS) and national Olympiad level (Olym)

#### 5. Discussion

In general, the profile of PPGSM3T participants of biology education department of UNY on PK, CK, and TK was in medium category. This result is resemble with the National Teacher Performance Examination (UKG). This performance was presumably affected by the curriculum of PPG and

educational background of the participants. The PPG curriculum consisted mainly of workshop, teaching practice, and doing classroom action research. The CK was not included as the main activity, therefore the participants scored low. The PK ability of PPGSM3T participants was in category of “good” in mastering the learning methods, but their mastery in curriculum and assessment is still low. It was suggested that the curriculum of PPGSM3T should be improved by adding the CK (Table 1).

**Table 1.** The proposed curriculum structure of biology teacher professional development program

Semester I	Workshop teaching materials as a group project*
	Presentation of the teaching materials
	Biology content mastery training**
	Peerteaching
	Classroom action research proposal (CAR)
Semester II	Teaching practice in a school
	Doing CAR
	Writing and presenting the results of the CAR
	Performance examination
	National examination (computer based test)

\*should be preceded by pretest of PK, CK, and TK

\*\*should added and conducted in the program

The second factor that might influence the low score of CK was the educational background of the participants. The participants of PPGSM3T came from various universities, both public and private; from educational and non-educational programs that were likely not equal in their quality. Therefore, before carrying out the workshop, participants should follow the standardized test to measure their prior knowledge on PK, CK, and TK. Then, they were given the matriculation in accordance with their test results. Participants who came from non-educational programs should follow matriculation on educational materials. The matriculation was important to equalize their initial knowledge toward the standard. The profile of PK, CK, and TK of the participants were in medium category likely was affected by the non-existing of matriculation program.

The participants of PPG SM3T have one year practice teaching in remote areas. The practice made them have a good ability in PK, specifically in curriculum, student development, learning theory, media, and assessment. This finding was accordance with learning theory of learning by doing, experiential learning, and service learning. The areas of curriculum understanding according to [14] included teachers' ideas about (1) scope of science, (2) using standards to guide planning and teaching science, (3) sequence of science, and (4) curricular resources available for science. However, one year teaching in remote areas did not contribute significantly to the development of CK.

## 6. Conclusion

- 6.1 Based on the data and discussion, the following conclusions can be drawn.
- 6.2 The CK, PK, and TK proficiency of prospective teachers of PPG SM3T program majoring in biology education at Faculty of Mathematics and Natural Sciences UNY is in average category and is not much different from national UKG score.
- 6.3 The mastery of CK of PPG SM3T teacher in high school biology material is higher than in the national Olympiad material that is 52.9 and 26.2 of scale 100. Thus, the mastery of CK, PK, and TK still needs to be improved.
- 6.4 The curriculum of PPG should be restructured to give more space on the development of CK.



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### **Acknowledgment**

It is our gratitude and thanks go to the participants of the teacher professional education program of Yogyakarta State University for the cooperation and participation in this research. The same gratitude and thank also go to the Department of Biology Education, the Faculty of Mathematics and Natural Science, Yogyakarta State University.