Analysis of Technological Pedagogical and Content Knowledge (TPACK) of Prospective Chemistry Teachers through Lesson Study

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Abstract. This study aims to analyze the profile of technological pedagogical and content knowledge (TPACK) for prospective chemistry teachers when taking teaching practice courses through Lesson Study activities. This research was conducted in the Chemistry Education Study Program of Jakarta State University and several schools in Jakarta. The method used in this study was a qualitative descriptive research method. The technique of collecting data results was conducted using TPACK questionnaires, lesson plan (RPP) assessment, content assessment, observation of the learning process, and reflective journal. The stages of research were in accordance to the modified Lesson Study stage, consisting of RPP preparation training that integrates TPACK components, implements RPP in learning, observes the learning process and reflects it. TPACK overview was obtained from the questionnaire. Observations showed that prospective chemistry teachers can make or use video, interactive power points in studying chemical balance and acid-base materials. Prospective chemistry teacher can also vary various methods such as demonstrations, discussions, games in the delivery of material and evaluating through online games. The result of the study indicated that the ability of TPACK from prospective chemistry teachers can be developed during the learning process from the perception levels to the Cn-Conception level category through lesson study.

1. Introduction
Technological Pedagogical Content Knowledge (TPACK) is knowledge about how to facilitate student learning from certain content through pedagogical and technological approaches [1-3]. Technological Pedagogical Content Knowledge (TPACK) is known as the field of educational research as a theoretical framework for understanding the knowledge needed by teachers to integrate the three domains: technological knowledge, pedagogy, and content [4]. Thus, Technological Pedagogical Content Knowledge (TPACK) must be developed by each prospective teacher. Some researchers reveal that technological advances in the 21st century require the use of technology in education [5-7]. Meanwhile, teachers not only lack knowledge about student-centered learning, but also lack of "knowledge about how to integrate technology into student-centered learning" [8].

Higher education institutions that produce prospective teachers are responsible for providing technology integrated learning [9]. TPACK is an important component that must be developed by
prospective teachers, because TPACK will influence the student in teaching [10]. This ability can certainly be improved through in-depth evaluation in each learning activity. Therefore, it is necessary to conduct in-depth observations by conducting Lesson Study activities.

Based on literature, Lesson Study is a process of developing core activities that are practiced by teachers in a sustainable manner in order to improve the quality of student learning experiences in the learning process. Research related to Lesson Study has continued to develop, so that implementing the Lesson Study framework shows effective characteristics of teacher professional learning [11]. In addition, Huang and Xu state that teachers who take part in Lesson Study activities will have better self-efficacy and quality of learning and a more explicit focus with more awareness of diverse student learning needs [12-13]. Lesson Study can be a new scheme in the activities of teaching skills practice courses for prospective teachers. However, further research needs to be done that can explain the underlying mechanisms and make Lesson Study effective [14].

Based on this background, the analysis of TPACK for prospective chemistry teacher was carried out in this study through the application of lesson study. The aim is to evaluate TPACK's ability and improve it. The method used qualitative approach. The main instrument is TPACK questionnaire which is used to describe the TPACK of preservice chemistry teacher.

2. Method
This study uses a qualitative descriptive method [15] with research according to three prospective chemistry teachers (ProsCT) who practice teaching in several secondary schools in Jakarta. Research data were obtained through TPACK questionnaire adapted from TPACK assessment instruments developed by Schmidt [16]. To get a TPACK overview, prospective chemistry teachers have been interviewed after the learning process and observed by the implementation of lesson study and reflective journals. TPACK's profile is categorized into four levels, namely Nn = no perception, Pn = level of perception, Cn = level of conception, and An = level of action [17].

3. Result and Discussion
3.1 Analysis of TPACK in the implementation of Lesson Study

3.1.1 First cycle
Lesson studies carried out have three stages, namely Plan, Do and See.

*Plan Stage*
This stage carries out the aim of planning or programming the learning process and what should be realized. Participants are active in expressing ideas related to the limitations of learning materials, methods to be applied and media technologies that facilitate students' understanding. Division of tasks is also seen when discussions between prospective teachers take place. Then one of the Prospective Teachers was chosen to carry out the learning design in the classroom, namely ProsCT-2.

| Respondents   | TPACK component |
|---------------|-----------------|
|               | TK  | PK  | CK  | TPK | PCK | TCK  |
| ProsCT-1      |     |     | √   |     |     |      |
| ProsCT-2      | √   |     |     |     |     |      |
| ProsCT-3      |     |     |     |     |     | √    |

A start from introduction is followed by core activities and closing activities. This lesson design shows some indications of the emergence of TPACK components. Table 1 shows the activity plan in the first cycle that identifies the emergence of TPACK components of each prospective teacher. ProsCT-
I can improve the PK components when the discussion process is carried out, this can be reinforced by the observational sheet.

"Using an experimental model can lead to an attitude of responsibility, cooperation etc" (Observation Sheet 1, October 27, 2018)

**Do Stage**
The learning of acid-base material starts with checking the attendance of students and beginning of learning by opening students’ initial knowledge (PK-Cn). Power points and animated videos are used for the learning process (TK-Cn). Besides that, also a brief explanation on the theory of acid-base follows an example of a reaction, an explanation of acid base indicators and examples in daily life (CK-Pn).

With the initial activity, the video develops initial knowledge or open up prior knowledge about acids and bases in daily life (TCK-Pn). In addition, other studies say that the use of videos also succeeded in attracting students’ enthusiasm at the beginning of learning [18], this was confirmed by the observation sheet: “The use of video successfully builds good learning and attracts high student enthusiasm for the initial concept of acid and base” (Observation Sheet 2, November 8, 2018)

Besides video, the model teacher also uses power point media that increases help time management and provide an overview to students so that interest in learning [19]. Besides the lecture method, the model teacher also applied the experimental method in the classroom: students were divided into small groups. Figure 1 shows the simple practical activities of students in the class. The model teacher wants to create meaningful learning of the acid-base concepts through this experimental method (PK-Cn). The continuity of delivering material to strengthen understanding and good learning experience developing for students (PCK-Pn), this is in line with research that says that a combination of learning methods can improve effectiveness [20].

![Figure 1. Students conduct simple acid base experiments](image)

**See stage**
This stage starts from the teacher who delivers an evaluation of learning activities, then be followed by an evaluation from the observer team: the author with some colleagues. This activity aims to make notes as a reference in making the next RPP. Experimental constraints occur in the availability of tools and materials such as drop pipettes, universal pH and red-blue litmus paper. Other prospective teachers also arranged in the learning evaluation discussion.

“The test samples in each group should be poured into containers and arranged alternately, so there is no crowd when students will take”.(PK) (Observation sheet, November 8, 2018)
The selection of experimental learning methods seems to have succeeded in providing a learning experience in introducing acid-base indicators with a note that there is a need for testing materials before learning starts.

3.1.2 Second cycle

Plan Stage

The learning strategy chosen is number head together (NHT). Previously the model teacher gave a task to summarize the concepts to be studied then students would be randomly chosen to explain in front of the class. Activities start from the Introduction, the core activities and end the closing activities.

| Table 2. Early Occurrence of Components of TPACK Cycle 2 from Prospective Teacher |
|-------------------------------|------|------|------|------|------|
| Respondents       | Component TPACK          |
|                  | TK | PK | CK | TPK | PCK | TCK |
| ProsCT-1         |   |   | √  |     |     |    |
| ProsCT-2         |   | √ |   |     |     |    |
| ProsCT-3         |   |   |   | √  |     |    |

The model teacher in the second cycle power point to explain the answers and conceptual material. Then the model teacher also takes uses the Kahoot app! It contains 15-20 questions in the answer period (TPK). However, the prospective teacher 3, also uses blackboards for strengthening each material (TCK) “The use of PPT or video can be additional, but for clarification, it still requires reinforcement with explanations on the board” (Observation Sheet 2, November 10, 2018)

Do Stage

The model teacher limits learning material by considering the level of material difficulty (CK-Pn), he uses a variety of learning models (PK-Cn). The learning media are interactive power points, videos related to songs that discuss basic chemical laws and Kahoot applications for evaluation (TK-Cn).

The learning model also provides space for students to interact with each other, because it is supported using power point in explaining the concept (TPK-Pn). So it can develop interaction among students, and between student and teacher. The student representatives answer questions in front of the class (PCK-Cn). After the material was thoroughly discussed the teacher model divided the students into small groups of four people. These groups will compete to get the highest points in answering some mole concept questions and basic chemical laws in the Kahoot application (TCK-Pn).

“The teacher uses various technology in the right momentum from starting PPT, Video and Kahoot! ” (Observation Sheet 2, November 15, 2018)
Figure 2 shows active students discussing the most appropriate answers, especially through the options presented in the Kahoot application. The Kahoot application attracts students' enthusiasm and increases the activeness of students in learning [21]. At the end of the lesson, the teacher re-explained the material as a conclusion for all students to remember the material being taught.

**See Stage**
The model teacher explains the implementation of videos containing songs related to the basic laws of chemistry. They are very interesting for students because they look more relaxed and their understanding is reinforced by the lyrics in the song. The application of group discussion methods was also appropriate when evaluating learning because the grouping consists of four people allowing the interaction that occurred.

Other prospective teachers provide input to the model teacher regarding interactions that need to be emphasized to students in the back row. Overall the model teacher has implemented the draft RPP into classroom learning.

### 3.2 Profile of TPACK Prospective Teachers

After the implementation of the whole series of Lesson Study activities, the profile of prospective teacher 2 was obtained during cycle 1 and cycle 2 as seen in Table 3.

| TPACK Components | Cycle 1   | Cycle 2   |
|------------------|----------|----------|
| TK               | TK-Cn    | TK-Cn    |
| PK               | PK-Cn    | PK-Cn    |
| CK               | CK-Pn    | CK-Pn    |
| PCK              | PCK-Pn   | PCK-Pn   |
| TCK              | TCK-Pn   | TCK-Cn*  |
| TPK              | TPK-Pn   | TPK-Cn*  |
| TPACK            | TPACK-Pn | TPACK-Cn*|

Remarks = Pn: Perception, Cn: Conception, * Changes

In Cycle 1, ProsCT-2 has a number of Cn 2 and Pn 4, which indicates that TPACK of prospective chemistry teachers is a category of perception, Pn. This means that prospective chemistry teachers already know every component of TPACK, but have not been able to integrate these components in the learning process. In cycle 2, ProsCT-2 has a number of Cn 4 and Pn 2. This indicates that TPACK of prospective chemistry teachers is the category of conception level Cn. This means that prospective chemistry teachers can express the relationship between content, pedagogical aspects and technology. Thus, Lesson Study activities can increase the teaching capacity of prospective teachers. This result is reinforced by another study stating that lesson study can provide more varied teaching knowledge [22].

### 4. Conclusion

Based on lesson plan analysis, learning observation, reflective journals, interviews and TPACK questionnaires during the learning process, prospective chemistry teachers already have PK-Cn, CK-Pn, TK-Cn, PCK-Pn, TCK-Pn and TPK-Pn. Thus, prospective chemistry teachers are categorized into the level of perception-Pn in the first cycle of lesson study. Then in the second cycle of lesson study, the prospective chemistry teacher showed an increase in the TPACK component into the Cn-conception level category, namely PK-Cn, CK-Cn, TK-Cn, PCK-Pn, TCK-Cn and TPK-Cn. These results indicate that Lesson Study can help prospective chemistry teachers improve their TPACK capabilities.

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