Analyse of chemistry teacher profiles using Technological Pedagogical and Content Knowledge (TPACK) framework

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Abstract. This study aims to analyze the profile of technological pedagogical and content knowledge (TPACK) chemistry teachers at one of the schools in Jakarta. The criteria for the teachers analyzed are professional teachers who have been certified and have more than 20 years of teaching experience. The method used in this study is a qualitative descriptive research method. The data sources were collected through the TPACK questionnaire, lesson plan analysis, observation of the learning process, and interviews. The results show that chemistry teachers can apply learning methods that vary each meeting according to the characteristics of acid-base material. The teacher also utilizes technology information & communication (ICT) based learning media to simplify and clarify material delivery. It can be concluded that teachers have pedagogical content knowledge (PCK) and technological content knowledge (TCK). The use of ICT media such as interactive power points, videos and mobile phones to support selected learning methods, shows that teachers are also competent in technological pedagogical knowledge (TPK). The results of the study concluded that the teacher had integrated all TPACK components into acid-based learning so that they belonged to the action category (Action Level/An) at the TPACK competency level. This result was obtained base on CK, PK, TPK competencies that met the standard conception (Cn) category, and TK, PCK, TCK competencies that met the standard perception (Pn) category. Cn are indicated by understanding theories about TPACK components and their implementation through learning. While the Pn only understands the theories of components from TPACK.

1. Introduction

Teachers are challenged to determine the right learning method for all students effectively. The teacher can be one of the causes of misconception, then the competency of a teacher needs to be seen again to avoid misconceptions [1]. Teacher in the learning process in class plays an important role. Based on government regulation number 18 of 2017 concerning teachers, states that the four competencies that must be possessed by teachers include pedagogical competencies, personality competencies, social competencies and professional competencies obtained through professional education. The four competencies are mutually exclusive, but in their application are interrelated. An international report that the new national standard in education is technology in education, aimed at teachers [2]. According to that research, the teacher was partially responsible for creating pedagogical experiences involving the use of technology for learning.
Teacher competency plays an important role in understanding teacher knowledge related to the use of information and communication technology (ICT) in the context of teaching [3]. So that knowledge of the ICT of a teacher needs to be seen from the competencies it has. TPACK's competence stands for technological pedagogical and content knowledge according to Mishra and Koehler, is a development of PCK (pedagogical content knowledge) competencies, where there are additional competencies in the form of technology [4]. Where a teacher must be able to connect competencies related to teaching content, teaching strategies and the use of technology that supports the meaningfulness of learning. This TPACK competency supports the application of technology in education in accordance with the demands. The use of TPACK as a competency to measure teaching knowledge designed by the teacher[5]. The formulation of technological, pedagogical and content knowledge competencies (TPACK) is an extension of the previous PCK theory. Teacher's knowledge is extended to technology in learning so that they can teach effectively [4], TPACK competencies are based on thoughts theorizing about the dimensions of knowledge called Pedagogical Content Knowledge (PCK) [6]. The components that make up the TPACK consist of; pedagogical (PK) knowledge, technology knowledge (TK), content knowledge (CK), pedagogical and technological knowledge (CAR), pedagogical knowledge and content (PCK) and technology and content knowledge (TCK).

A teacher's TPACK competency can be evaluated by performance assessment instruments [7]. His research adds performance items to the TPACK indicator. Performance items describe how a teacher can turn on a classroom atmosphere to make learning meaningful. Learning that is created by the teacher by collaborating pedagogically, content, and technology. Meanwhile, examined the validity of the instruments developed to measure the competence of chemistry teachers in China in the form of TPACK's competency questionnaire and lesson plan assessment rubric [8]. The results from the study showed that the instruments used were valid so that the observation data became a reference in developing teacher competencies in China. Some of the above studies have discussed the competencies of TPACK teachers in learning from the measurement side. According to the previous research about PCK competency is not enough to be studied and taught in the 21st century [9]. The research, emphasizing the development of TPACK competencies in prospective teachers can build 21st centuries learning through prospective teacher education and training. Teacher candidates are prepared to be able to access various technological devices that support learning. So that the application of ICT curriculum (information and communication technologies) for students by teachers is more mature.

Chemists distinguish phenomena and chemical teaching materials at three levels of representation namely; macroscopic, submicroscopic, and symbolic, all of which are related to each other [10]. Because the acid-base concept represents macroscopic, symbolic, and submicroscopic levels, there are quite a lot of misconceptions. Then the teacher must teach correctly to students. Teachers who have good TPACK competencies should be able to form students who understand the right concepts. Formulation of the problem in this study; What is the teacher's TPACK profile in teaching acid-base material?

2. Method
The study was conducted in class XI at State High School 26 Jakarta in the even semester of the 2018/2019 academic year. The subjects of this study were one chemistry teacher who taught in class XI. The sampling technique used was purposive sampling where the chemistry teacher with the criteria for teaching experience was more than 30 years and had obtained certification as a professional teacher. The form of research used in this study is qualitative. The method applied in the study is descriptive in that the researcher will describe the facts in the research sample during the study without giving treatment to the research variances. Collection of qualitative research data through: observation, TPACK questionnaire, documentation, reflective journal of students and teacher interviews [11]. Teacher TPACK’s profile belongs to four categories namely, Nn (Non-Perception Level), Pn (Perception Level), Cn (Conception Level) and An (Action Level) [12]. The benefits of this research are for researchers and educators to better understand the important role of TPACK's ability in the learning process in acid-base material. So that researchers and educators know how or the right method in providing learning or lectures about acid-base material to their students.
3. Result

3.1. The first cycle of TPACK competency analysis

The concept of acid base is divided into several concepts taught in each week, namely the theory of acid base, acid base indicator, the concept of calculating a single soluble pH, the concept of pH in weak acids and weak bases, calculation of mixed pH. Participants divide the meeting into three weeks in the number of meetings six times outside of the learning evaluation process. In the design of study, participant identified and shared the acid-base theory concept into simple content into a more imagined form of representation, namely theory according to Arrhenius, Bronsted-Lowry and Lewis. Each theory is discussed by the teacher by giving examples of reactions to acids and bases and their weaknesses (CK-Cn). Participants use the learning method in the form of information discussions with the teacher as a facilitator in the class (PK-Cn).

![Figure 1](image1.png)  
**Figure 1.** (A) and (B) are the learning process using information discussion.

Figure 1 shows during the discussion, the students were directed by the teacher to be able to explain themselves the right theory of acid base from the search results using a mobile phone (TPK-Cn). They seemed to enjoy learning while searching information with mobile phone. At the first meeting, the participants used a mobile phone to support the class discussion process so that students could find information related with the theory of acid base and then written on the whiteboard by students (TK-Pn). Participants use discussion of information in the concept of acid base theory so that students can explore their own knowledge and find the concept of acid base itself (PCK-Pn). In addition, participants also facilitate students using mobile phones, so they can search for information in the form of pictures, videos or explanations to help realize the difficulties found by students (TCK-Pn). Based on the TPACK components described, the participant's TPACK capability is included in the perception level category because participants can identify content difficulties and are able to identify teaching methods that are appropriate for the technology to create structured learning.

3.2. The second cycle of TPACK competency analysis

In the design of study, participant identify and share the concept of indicators of acid and alkaline substances into simple content into a more imagined form of representation, namely indicators of acids and alkaline substances derived from natural ingredients and synthesis materials. Each of these indicators is introduced to students through demonstrations (CK-Cn). Participants apply learning methods in the form of demonstrations in the classroom (PK-Cn). At the meeting in the second week participants took advantage of learning media, namely laboratory equipment, mobile phones and whiteboards (TK-Pn).

The demonstration that takes place can attract the concentration of students and the teacher makes good use of time. Students are also directed by the teacher to be able to search for their own basic ingredients of the natural indicators they are trying. Such as the color and shape of natural materials used as natural indicators using mobile phones (TPK-Cn). Participants use the demonstration method in
the acid base indicator concept so that students can explore their own knowledge and recognize the acid-base indicator itself (PCK-Pn).

![Figure 2](image1.png)

**Figure 2.** The acid base indicator demonstration learning method (documentation, 15 January 2019).

Figure 2 show Learning process by applying the acid base indicator demonstration learning method and utilizing a mobile phone to dig up information in the second week. The students look so interesting while studied. According to the teacher in the interview during the preparation of the lesson plan, this method is best used to attract the attention of students. He explained;

"Class demonstrations can save time to continue learning and provide a deep experience for students because they also do (try to and observe)" (Chemistry teacher, 7 January 2019)

In addition, participants also facilitate students using mobile phones, so they can search for information in the form of images to help realize natural materials in natural indicators (TCK-Pn). Based on the TPACK components described, the participant's TPACK capability is included in the perception level category because participants can identify content sharing and are able to identify appropriate teaching methods by utilizing technology to create meaningful learning.

### 3.3. The third cycle of TPACK competency analysis

Participant identified and shared the concept of calculating pH values into simple content, namely the calculation of strong acid and base pH, weak acid and alkaline pH, pH of a single solution and mixed pH. Each concept is explained and given an example of problem solving (CK-Cn). Participants applied the learning method in the form of direct instruction and group discussions in the computer laboratory also in the classroom (PK-Cn). At the third week of the meeting participants took advantage of learning media, namely power point, video, Ms. Office Word and whiteboard (TK-Cn).

The direct instruction method is used because according to the teacher whom the concept of calculation must be explained in detail so that students do not misunderstand it. The method is supported by using power point to provide interesting visuals for students (TPK-Cn). Participants also made several quizzes related to the concept of calculating pH in power point so that students competed to answer the quiz correctly. Indirectly the teacher can evaluate the understanding of the concepts held by students regarding the concept of calculating pH (PCK-Pn). Strengthening of students in the journal notes states that;

"Today's learning is quite interesting because using PPT accompanied by quizzes is more motivated to answer because there is a mistake in the answer, there are emoticons coming out on PPT. At first, I thought it was very difficult to calculate pH because I used the log, but after being taught by the teacher it was not as difficult as I imagined. " (Student, 23 January 2019)

In addition, participants also facilitate students using power point so that they can record concept summaries and compete to answer the existing quiz (TCK-Pn).
Figure 3. (A) and (B) are the learning process applying the direct instruction method while (C) is group discussion (documentation, 22 and 23 January 2019).

Figure 3 shows the learning that is done by the teacher with variations in methods and interactions that occur within it. Based on the TPACK components described, the participant's TPACK capability is included in the perception level category because participants can identify content sharing and are able to identify appropriate teaching methods by utilizing technology to create interesting learning.

The learning evaluation process was carried out using a description test instrument to see where to understand the concepts of acid base obtained by students. In the RPP made by the teacher, the implementation of IT-based evaluations where replications are presented through online exam portals by familiarizing the school's mission to reduce waste, one of which is paper waste. However, because the class XII tries out schedule is in conjunction with the repetition schedule, the computer laboratory cannot be used for repetitions of class XI students. So that the replay is done manually using paper questions not like the previous tests carried out online.

3.4. Analysis of TPACK chemistry teacher's profile on acid-base concept

Based on the TPACK questionnaire instrument that has been filled by the teacher, the ability of high school chemistry teachers in planning learning of the concept of acid base uses a variety of methods such as information discussions, demonstrations, lectures, and group discussions. This is due to the demands of the 2013 curriculum which requires that students themselves find concepts in the material. In addition, supporting technology in the learning process takes the form of interactive power points, videos and mobile phones so that students find information more easily. In the learning process, the teacher only acts as a facilitator in the class. If there is material that is considered difficult or misinterpretation of the concept by students, the teacher will begin to correct it with the correct explanation to the students.

The ability of the chemistry teacher in the high school has understood and created the TPACK component during classroom learning. So that the teacher's ability is included in the action level category (Action Level-An). At this level of action, the teacher can create learning by combining content, pedagogical and technological in the classroom, which are all components of TPACK. Because it uses a variety of learning methods, the teacher can identify the content difficulties experienced by students, so they can direct them to re-understand the concept in the form of simple content with the support of the use of appropriate technology, namely a set of power points, videos and images. These results show that the chemistry teacher in the high school can identify content difficulties and be able to identify appropriate teaching methods by utilizing technology. The planning and implementation capabilities of the high school teacher's TPACK are parallel.

One of the factors that influence TPACK's ability is the large amount of learning experience from the field, also through seminars held by the government with the aim of improving the quality of teachers. So that the duration of teaching experience is directly proportional to the increase in TPACK's ability. This is influenced by many factors, including senior teachers can take the time to learn new things, especially technological advances in supporting the teaching process in the classroom. Because
the teacher can manage his time well and has mastered the class conditions. So that the application of learning methods did not escape the incorporation of conventional methods (lectures) with the use of various technologies in order to improve the existing education system. And the use of technological developments in education

4. Conclusion
Based on the results from the study it was concluded that, the level of TPACK ability in the high school teacher in acid-base topic was directly proportional to the length of teaching experience. The TPACK profile of the teacher was classified as the Action Level (An) category. This means that the teacher can understand the relationship between the content, pedagogical and technological aspects implemented in learning. Teachers who have the competency TPACK Action Level (An) can teach the acid-base concepts efficiently and precisely.

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