Investigating the Competencies of Technological Pedagogical Content Knowledge and Self-Efficacy of Chemistry Teachers

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Abstract: Technological Pedagogical Content Knowledge (TPACK) is an integration knowledge between technology, content of learning, and pedagogy which obtain to an integrated learning based on computer technology. Moreover, the pre-service teachers have a strengthen competencies of teachers integrating to knowledge, pedagogic, and technology. This research is aimed to investigate the Technological Pedagogical Content Knowledge competencies related to self-efficacy of chemistry teachers in Serang regency, Banten, Indonesia. Furthermore, the writers use a descriptive analysis as the research methodology. The sample of this research involves sixty-one chemistry teachers in the Senior High School level located at Serang city and Serang regency. To analyze the data, the writers provide a Likert scale. The result showed that the TPACK competencies scores in both Serang city and Serang regency raise up to 76.2 and 77.9 representatively. Whereas, the self-efficacy score in the two regions proved into 77.0 and 79.1 chronologically. Based on the data showed, it can be concluded that the relationship between TPACK and self-efficacy cannot be separated one another. Therefore, the Technological Pedagogical Content Knowledge (TPACK) and self-efficacy of the Chemistry teachers are comparable to the competencies of the Chemistry teachers.

Keywords: Technological Pedagogical Content Knowledge; Self-efficacy; Chemistry teachers.

1. Introduction
Nowadays, the development of science has increased rapidly because of some factors. It is supported by the technology usage in many different countries which can help people to finish any kind of works on time. As one of the developed countries, the government of Indonesia also tries to use the technology particularly in education field which implement the technology in teaching and learning process. Furthermore, the impact of the globalization has influenced the use of technology which can be a fundamental challenge for the teachers [1].

Argued that the most popular topic to be discussed about the integration of Pedagogical Content Knowledge and technology is the Technological Content Knowledge (TPACK) [2]. Technological Pedagogical Content Knowledge (TPACK) is the knowledge about how to facilitate the learning of students from certain content through the pedagogic approach and technology [3, 2, 4]. Moreover,
TPACK is considered as a potential framework that can provide a new technique for teachers in solving the problems related to the integration of computer and information technology in teaching and learning process [5].

In fact, it cannot be denied that the integration of materials, pedagogy, and technology is needed in enhancing the quality of education in Indonesia. In the advanced countries, the integration of these three aspects are combined in a competency called Technology, Pedagogy ad Content Knowledge (TPACK) which was pioneered by Misra as the useful solution to be developed in learning process [6]. Moreover, TPACK is an integration between technology, teaching materials, and pedagogy which related to one another in producing the learning based on Computer Information Technology (ICT). So, this ability can differ the chemistry teachers to other teachers that integrates the knowledge, pedagogy and technology in the whole classroom activities [7].

Mastering the TPACK competencies is a kind of responsibility of the teachers that are able to influence the quality of teaching of the teachers. Tuqba and other researchers stated that the use of Technological Pedagogical Content Knowledge can improve the education performance and create a positive vibe to upgrade the teachers’ confidence in teaching the materials given. This is caused by the teachers who have a qualified knowledge will be able to transmit the materials through the pedagogic knowledge and integrate to the technology usage in increasing their self-efficacy.

Self-efficacy is a self-assessment, whether someone can perform actions well or not, right or wrong, was able to work on something or not in accordance with the required. To be more specific, a self-efficacy is different to the aspiration, because the aspiration only describes something ideal that should be achieved, while self-efficacy explains the assessment of the ability of self [8]. Pertaining to by exposure to above so as to group of researcher from interested in taking part in looking at the even closer ties between Technological Pedagogical Content Knowledge (TPACK) relating to Self-Efficacy teacher chemistry at the Senior High School or Madrasa in Serang Banten.

The rest of this paper is organized as follow: Section 2 describes the proposed research method. Section 3 presents the obtained results and following by discussion. Finally Section 4 concludes this work.

2. Proposed Method

The writers use a descriptive methodology in presenting the data of the research. Comparing to another methodology, this research focuses on describing the facts systematically and the characteristic of an object properly [9]. A quantitative research is concerned to a scientific activity which focuses on deciding of the topic to be examined, formulating the research problems specifically, collecting the data from the participants, analyzing the data through statistical technique [10]. Then, the writers also provide thirty questions in the questionnaire of TPACK. And self-efficacy. The following Likert scale compiled by adapting the instruments developed by [11]. While the self-efficacy questionnaire drawn up with adapting the instrument developed by [12]. The questionnaires consisted of thirty questions and would be measured by a Likert scale (4-3-2-1) through various categorizations such as very good, good, enough and lack.

The reliability of [13] instrument of Technological Pedagogical Content Knowledge (TPACK) has a Cronbach’s Alpha 0.871 and Self-efficacy instruments may be Cronbach’s Alpha 0.901 with high category. This data Showed in the Table 1 below:

| Data             | TPCK  | Self-efficacy |
|------------------|-------|---------------|
| Cronbach’s Alpha | 0.871 | 0.901         |
| N of Items       | 30    | 30            |
| Description      | Good  | Very Good     |

Table 1. Recapitulation data test reliability the questionnaire TPCK and Self-efficacy
After collecting the data from those questionnaires, those data would be calculated on the percentage and analyzed by descriptive technique. The data analysis using IBM SPSS statistics programs Version 22, describing the results of data Technological Pedagogical Content Knowledge (TPACK) and self-efficacy to measure the ability of chemistry teacher. Than, between Technological Pedagogical Content Knowledge (TPACK) relating to Self-Efficacy teacher chemistry in Serang Banten, give an interpretation in correlation index Pearson’s Correlation this data showed Table 2 below:

**Table 2. Hypothesis testing shows correlation competence TPACK and Self-efficacy**

| Data                           | Serang Regency | Serang City |
|--------------------------------|----------------|-------------|
| *Pearson Correlation*          | 0.635          | 0.885       |
| N of Items                     | 30             | 30          |
| Description                    | enough         | strong      |

Description interpretation against the correlation index in very simple terms using of categorization such as very low (0.00 – 0.20), low (0.20 – 0.40), enough (0.40 – 0.70), strong (0.70 – 0.90), very strong (0.90 – 1.00) [14].

### 3. Results and Discussion

This section presents the results obtained and following by discussion.

**3.1. The Competencies of Technological Pedagogical Content Knowledge of the Chemistry Teachers in Serang Regency and Serang City**

Based on the research finding, the writers found that the average score of TPACK showed in a good category which had been accumulated as follow; 76.2 in Serang City and 77.9 in Serang Regency. Additionally, the analysis of TPACK competencies has been carried out to compare the TPACK scores in both places. The data showed in the Figure 1 below:

**Figure 1. The Analysis of each Competency in TPACK Aspect of the Chemistry Teachers**

Based on the diagram above, all aspects of competence Technological Pedagogical Content Knowledge (TPACK) chemistry teacher is included in both categories. As for the value of the highest average percentage Technological Pedagogical Competency Content Knowledge (TPACK) is the
highest in any Government/city. The highest average percentage in the Serang Regency acquired for 83.3 on aspects of Technological Pedagogical Knowledge (TPK); in the town of Serang acquired for 77.6 on Pedagogical Knowledge (PK) and the Technological Pedagogical Knowledge (TPK); the average lowest on this aspect of the Technological Knowledge (TK) of 73.1 Serang Regency and amounted to 72.3 Serang. The thing that is assessed on aspects of Technological Knowledge (TK) is the ability of teachers on technological knowledge about operating computers and relevant software [11]. Research [15] shows that the biggest contributing factor on TPACK model i.e. variable Technology knowledge with the role of these indicators that contribute the greatest form of ability techniques in using technology. Similar statements related to research [16]. The ability of chemistry teacher against technological knowledge about operating computers and use of computer applications in the school environment is still lacking. This happens because the teachers are not familiar and less avail media use ICT in the learning process as well as the assessment of the application in the surroundings of the school.

3.2. The Self-Efficacy of Chemistry Teachers in Serang Regency and Serang City

Based on the research conducted by the expert about examining the self-efficacy of the chemistry teachers, it proves that the data obtained the results of the analysis of the self-efficacy in Serang city and Serang Regency of 77.0 and 79.1 average either. This is due to the Self-efficacy of each individual varies. In line to the previous research conducted by [17], they argued that the enhancement of TPACK knowledge can increase the teachers’ self-efficacy in teaching the materials. Each aspect of self-efficacy can be described in Figure 2 as follows:

![Figure 2](image-url)

**Note:** Science Content (SC), Higher-Order Thinking (HOT), Laboratory Usage (LU), Everyday Application (EA), Science Communication (SCM), dan Scientific Literacy (SL).

**Figure 2.** The Analysis of each Competency in Self-Efficacy Aspect of the Chemistry Teachers

Based on the diagram, it can be seen that in the Serang Regency obtained the highest average percentage on aspects of the use of the laboratory and applications in everyday life of 80.0 (very good) and lowest on this aspect of the skills higher-order thinking (HOT) amounted to 76.3 (good). In the town of Serang obtained the highest average percentage on aspects of communication science amounted to 78.5 (good) and lowest on the higher-order thinking skills (HOT) amounting to 75.8 (good). Aspects of the lower HOT Skills due to gurus are not accustomed to internalize HOT both in the learning process and in the assessment process. The impact of students into trouble in answering the problems and questions which are not accompanied by a HOTS-based in-process analytical study. Especially when answering question in National computer-based Exam in 2018. The assessment done on aspects of skills is assessing the HOTS competency of the chemistry teacher towards their abilities...
in utilizing the cognitive skills that are able to increase the critical thinking skills of students in learning Chemistry [18].

3.3. The Relationship between the Competence of Technological Pedagogical Content Knowledge, Self-efficacy and Gender of Chemistry Teachers at Serang Regency and Serang City

The relationship of Technological Pedagogical Content Knowledge (TPACK) competencies to the self-efficacy has been analyzed by using statistical correlation Pearson product moment. Based on the results of a test of the hypothesis, there is significance value of less than 0.05. It shows that there is a relationship between Technological Pedagogical Content Knowledge (TPACK) of sixty-one teachers in Serang Regency and Serang City with the self-efficacy. Furthermore, this is manifested by the value of Pearson's Correlation shows 0.635 and 0.885, that correlation Technological Pedagogical Content Knowledge (TPACK) and self-efficacy of chemical teachers included in the category of strong ties on both variables such. In accordance with the results of research conducted by Karakaya and Yazici [19]. It is stated that the use of Technological Pedagogical Content Knowledge (TPACK) in curriculum development give a positive impact to the self-efficacy for science teachers. Their research is focused on the integrated curriculum with the use of technology in order to provide an effective in learning, pedagogy, knowledge and science learning.

Besides, the writers also analyzed the relationship between Technological Pedagogical Content Knowledge (TPACK) and self-efficacy of the chemistry teachers in each indicator as described in Figure 3 as follow:

![Figure 3. TPACK Competencies of Chemistry Teacher Based on the Gender](image)

The average value of the percentage of Technological Pedagogical Content Knowledge (TPCK) chemistry teacher in the Serang Regency and Serang city with gender male acquired for 79.4 (Good) and self-efficacy of 83.3 (very good). While the average percentage of Technological Pedagogical Content Knowledge (TPCK) and self-efficacy with chemistry teacher sex women acquired for 77.3 (good). The average value of the percentage of Technological Pedagogical Content Knowledge (TPCK) and self-efficacy among teacher sex with both men and women are included in the category either. It can therefore be concluded that gender does not affect the competence of Technological Pedagogical Content Knowledge (TPACK) and self-efficacy significantly [19]. In his studies of the gender factor does not affect the stated Technological Pedagogical Content Knowledge (TPACK) with self-efficacy on prospective science teachers at the University of Turkey. This is a test or tests carried out related to the development of the competency of the TPACK to prospective science teachers who are in University of Turkey. While, the ability competency of Technological Pedagogical Content Knowledge (TPCK) good then it will affect self-efficacy.
4. Conclusion
The chemistry teachers’ understanding of Technological Pedagogical Content Knowledge (TPACK) in both Serang city and Serang regency can be classified into a good category with the average percentage 78.4. Specifically, the percentage average of TPACK for each place reaches to 76.2 and 77.9 respectively. On the other hand, the self-efficacy score in the two places shows in a very good category with the average percentage 80.25. Also, it points out that the self-efficacy in Serang city is about 77 (good), while the score for another one is about 79.1 (good). Therefore, it can be concluded that Technological Pedagogical Content Knowledge (TPACK) and self-efficacy are two components that have a significant relationship between one to another proved by the Significance score of Person Correlation 0.635 and 0.885. Based on these scores, it can be seen that the TPACK and self-efficacy are related to each other. While, gender and school’s origin did not influence the understanding of Technological Pedagogical Content Knowledge (TPACK) and self-efficacy. It is caused by some factors such as competencies skill, teacher’s quality, social, culture and environment which also can affect Technological Pedagogical Content Knowledge (TPACK) and self-efficacy.

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References
[1] Ferdig, R. E. (2006). Assessing technologies for teaching and learning: understanding the importance of technological pedagogical content knowledge. British Journal of Educational Technology, 37(5), 749–760.
[2] Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: a framework for teacher knowledge. Teachers College Record, 108(6), 1017-1054.
[3] Cox, S., & Graham, C. R. (2009). Diagramming TPACK in practice: Using and elaborated model of the TPACK framework to analyse and depict teacher knowledge. TechTrends, 53(5), 60–69.
[4] Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15(2), 4–14.
[5] Koh, Joyce, HL., Ching, S., & Min, H. (2015). Technological Pedagogical Content Knowledge (TPACK) for Pedagogical Improvement: Editorial for Special Issue on TPACK, Asia Pacific Edu Res. 24(3), 459–462. DOI 10.1007/s40299-015-0241-6
[6] Sutrisno, (2012) Kreatif Mengembangkan Aktivitas Pembelajaran Berbasis TIK. (Jakarta: Gaung Persada, 2012)
[7] Muhammed, Dogukan B&Aysegii Ergun, Science Teacher Candidates’ views About Technological Pedagogical Content Knowledge (TPACK). (2017). Journal of theory and Practice in Education. 13 (4), pp. 570.
[8] Alwisol, 2009. Psikologi Kepribadian. Malang: UMM Press.
[9] Sukardi. (2007). Metodologi Penelitian Pendidikan. Yogyakarta: Bumi Aksara
[10] Creswell, J.W. (2005). Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research (2nd ed.). Upper Saddle River, NJ: Pearson Education.
[11] Chai, C.-S., Koh, J. H.-L., & Tsai, C.-C. 2013. A Review of Technological Pedagogical Content Knowledge. Educational Technology & Society, 16 (2), 31–51.
[12] Suprapto, N., Te-Sheng Chang, Chih-Hsiung Ku. (2017). Conception of Learning Physics and Self-Efficacy Among Indonesian University Students. Journal of Baltic Science Education, Vol. 16, No. 1, 2017
[13] Balçın, D.M. & Ergün, A. (2016). Fen bilgisi öğretmen adaylarının materyal geliştirme konusundaki teknolojik pedagojik alan bilgisi (TPAB) öz-yeterlik ölçüğü: geliştirme, güvenirlük ve geçerlik çalışması. Turkish Journal of Education, 5(3), 109-122.
[14] Sudijono, Anas. (2012). Pengantar Evaluasi Pendidikan. Jakarta: PT. Raja Grafindo Persada
[15] Puspitarini, Sony Sunaryo, dan Erma Suryani. (2013). “Pemodelan Technological Pedagogical Content Knowledge (TPCK) Berbasis Teknologi Informasi dan Komunikasi (TIK) dengan Pendekatan Structural...
Equation Modeling (SEM)”.

[16] Calik, M. (2013). Effect of Technology-Embedded Scientific Inquiry on Senior Science Student Teachers’ Self-Efficacy. *Eurasia Journal of Mathematics, Science & Technology Education*, 9(3), 223-232.

[17] Graham, R. Charles, et, all. Measuring the TPACK Confidence of Inservice Science Teachers. *Journal TechTrend*, September/Oktober Volume 53, No. 5, 70 – 79, 2009

[18] Mairisiska, Sutrisno, Asrial. (2014). Pengembangan Perangkat Pembelajaran Berbasis TPACK pada Materi Sifat Koligatif Larutan untuk Meningkatkan Keterampilan Berpikir Kritis Siswa, *Jurnal Edusains* Volume 3 Nomor 1, 28 -37.

[19] Karakaya, Ferhat., Mustafa Yazici. (2017). Examination Of Technological Pedagogical Content Knowledge (TPACK) Self-Efficacy For Pre-Service Science Teachers On Material Development. *European Journal of Education Studies*. Volume 5 Issue 3. 252-270.