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# Analysis of Pedagogical Content Knowledge Topic Specific PCK Model for Chemistry Teachers at the Vocational School of Semarang in Stoichiometry

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**Abstract**

Pedagogical Content Knowledge (PCK) is an integration between subject matter knowledge (SMK) or content knowledge (CK) and pedagogical knowledge (PK) owned by teachers as a way to improve student learning and will develop over time and experience. PCK is not only emphasized on content knowledge but with pedagogical knowledge and balanced with teaching experience so that the knowledge and experience can be integrated into a whole knowledge called PCK. The purpose of this study was to analyze the ability of PK, CK, and PCK chemistry teachers at the Vocational School of Semarang. This research is a descriptive study to describe chemistry teacher PCK. The subjects of this study were chemistry teachers gathered in the MGMP Kimia SMK in Semarang. The data are in the form of content and pedagogical knowledge test and TSPCK instruments. The PCK teacher's ability was obtained by analyzing the TSPCK instrument. Based on the analysis shows the following things: (1) the teacher has a good average pedagogical knowledge value (76%); (2) the teacher has an average score of content knowledge very good (82%); and (3) the ability of PCK teachers, there are 2 teachers in the examplary category, 17 teachers in the developing category, and 3 teachers in the basic category. Teachers who have content or pedagogics knowledge or both are not guaranteed to produce effective learning.



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## INTRODUCTION

In commemorating the National Teacher's Day in 2018, the Ministry of Education and Culture touched on the theme of the theme of the Industrial Revolution 4.0 , it required professional teachers who were able to utilize super-fast technological advancements to improve the quality of teaching and learning in each education unit. Improving the quality of education is determined by the readiness of human resources involved in the education process. Teachers are one of the determinants of the high and low quality of educational outcomes having a strategic position , so every effort to improve the quality of education needs to pay great attention to improving teachers both in terms of quantity and quality.

Regulation of the Minister of National Education of the Republic of Indonesia Number 16 of 2007 regarding Academic Qualification Standards and Teacher Competencies, it is explained that teachers are required to have and develop 4 competencies, namely pedagogic, professional, personal, and social. The Subject Teachers' Conference (MGMP) is a strategic forum for improving teacher and student competencies in order to improve the quality of education in general. But seeing the reality in the field of the existence of MGMP there are still many limitations. These limitations can be seen from human resources, the involvement of management and participants is not optimal, limited operational funds, coordination between MGMP and guidance and attention from education stakeholders is still not optimal .

A good teacher must master the content (subject matter) and teaching (pedagogic). Content knowledge and pedagogical knowledge must be integrated in learning to create new knowledge, namely Pedagodical Content Knowledge (PCK) (Shulman, 1986) . According to Loughran, et al. (2006), PCK is an academic idea that illustrates an idea that can arouse interest in learning something. PCK was developed by the teacher through experience about teaching certain content in a certain way also to increase student understanding. The teacher must understand and be able to integrate content knowledge into knowledge about the curriculum, learning, and characteristics of students. In order to represent the PCK of a science teacher, Mavhunga & Rollnick (2013) developed a format that covers important aspects of a science teacher in understanding the subject of science and pedagogical subjects called Topics Specific Pedagogical Content Knowledge (TSPCK).

Based on the pre-research results, it is known that learning that takes place in class, the teacher still applies the traditional learning system that is the teacher comes with the material and students listen.This makes learning chemistry monotonous so learning chemistry tends to be considered boring. Plus the curriculum implementation that requires teachers using student-centered learning. In this regard, teachers have difficulty in applying the scientific method or better known as the scientific approach . This fact is reinforced by the findings of some Semarang vocational school chemistry teachers who still lack understanding of the scientific approach. So that learning methods such as inquiry and discovery are still in their ears.

The problems described are showing that PCK possessed by Chemistry Teacher at Vocational School in Semarang still low. Seeing the gaps above, it is necessary to have an effort in improving teacher PCK. PCK training for chemistry teachers is necessary and important to have competency according to Minister of Education Regulation No. 16 of 2007 (Haryani, 2016). According to Purwaningsih (2011) debriefing PCK helps in mastering the material, increasing the ability to master and apply pedagogics , and increasing motivation in deepening the material and pedagogics as well as its integration in classroom learning.

Based on the background of the problems outlined above, the researcher is interested in conducting further research on "Analysis of *Pedagogical Content Knowledge Topic Specific* PCK Model for Chemistry Teachers at the Vocational School of Semarang in Chemistry Stoichiometry".

## METHODS

This research is a descriptive study to describe the ability of PCK chemistry teachers . The subjects of this study were chemistry teachers gathered in the MGMP Kimia in Semarang. The instrument of data acquisition mastery of PK and CK uses pedagogical knowledge and content tests. While the PCK teacher's ability to use the TSPCK instrument (Mavhunga, 2012). Descriptive analysis is performed on the data obtained. PK and CK mastery test results to obtain a description of pedagogical and content abilities. While the TSPCK results were analyzed in several aspects to obtain a description of the ability of PCK. Aspects used to analyze teacher PCK include: (1) *learner's prior knowledge,* (2) *curricular saliency* , (3) *understanding of what makes topics easy or difficult to understand* , (4) *representations/analogies /models ,* and (5) *conceptual teaching strategies* .

Data that has been classified based on TSPCK aspects are then analyzed using the TSPCK rubric to determine scores and make PCK categorization based on levels. The PCK categorization can be seen in Table 1 .

**Tabel 1.** PCK Categories

| No. | TSPCK Score | Category |
|---|---|---|
| 1 | 0 - 1,4 | Limited |
| 2 | 1,5 - 2,4 | Basic |
| 3 | 2,5 - 3,4 | Developing |
| 4 | 3,5 - 4 | Examplary |

## RESULTS AND DISCUSSION

### Pedagogical Knowledge (PK)

Based on data analysis, the Pedagogical Knowledge (PK) profile of vocational chemistry teachers in Semarang is presented in table 2.

**Tabel 2.** Distribution Pedagogical Knowledge Score

| No | Teacher | *Pedagogical Knowledge* | | | | | | | | | | Score | Percentage (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G | H | I | J | | |
| 1 | RAD | 9 | 7 | 3 | 6 | 3 | 7 | 1 | 9 | 3 | 5 | 53 | 88 |
| 2 | PNI | 9 | 8 | 3 | 6 | 2 | 6 | 1 | 9 | 3 | 5 | 52 | 87 |
| 3 | SUW | 9 | 6 | 3 | 5 | 2 | 7 | 1 | 10 | 3 | 5 | 51 | 85 |
| 4 | NKM | 8 | 7 | 3 | 5 | 4 | 6 | 1 | 9 | 2 | 5 | 50 | 83 |
| 5 | IKA | 7 | 6 | 3 | 5 | 5 | 7 | 1 | 10 | 3 | 3 | 50 | 83 |
| 6 | UNG | 9 | 7 | 3 | 4 | 5 | 6 | 0 | 8 | 3 | 4 | 49 | 82 |
| 7 | DVY | 7 | 6 | 3 | 3 | 5 | 7 | 0 | 9 | 3 | 5 | 48 | 80 |
| 8 | RTA | 9 | 5 | 3 | 5 | 2 | 7 | 1 | 10 | 3 | 3 | 48 | 80 |
| 9 | AYK | 10 | 5 | 3 | 3 | 5 | 7 | 0 | 7 | 3 | 4 | 47 | 78 |
| 10 | EST | 8 | 6 | 3 | 5 | 3 | 5 | 1 | 9 | 3 | 4 | 47 | 78 |
| 11 | NVL | 10 | 5 | 2 | 5 | 3 | 5 | 1 | 9 | 3 | 3 | 46 | 77 |
| 12 | NNK | 9 | 6 | 2 | 5 | 3 | 6 | 1 | 8 | 3 | 3 | 46 | 77 |
| 13 | TRS | 8 | 5 | 2 | 6 | 3 | 7 | 1 | 6 | 3 | 3 | 44 | 73 |
| 14 | NTL | 7 | 4 | 3 | 5 | 5 | 5 | 1 | 6 | 3 | 4 | 43 | 72 |
| 15 | SRI | 7 | 5 | 3 | 5 | 4 | 5 | 0 | 8 | 2 | 4 | 43 | 72 |
| 16 | AGF | 10 | 5 | 2 | 5 | 3 | 5 | *1 | 8 | 1 | 3 | 43 | 72 |
| 17 | SHF | 9 | 5 | 1 | 5 | 5 | 3 | 1 | 8 | 2 | 3 | 42 | 70 |
| 18 | FRD | 7 | 4 | 3 | 4 | 3 | 6 | 0 | 8 | 3 | 2 | 40 | 67 |
| 19 | FMS | 9 | 4 | 2 | 6 | 3 | 4 | 1 | 6 | 2 | 3 | 40 | 67 |
| 20 | AHM | 7 | 4 | 2 | 4 | 4 | 5 | 1 | 7 | 2 | 2 | 38 | 63 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | IND | 9 | 4 | 2 | 4 | 4 | 5 | 1 | 7 | 1 | 2 | 39 | 65 |
| 22 | AND | 7 | 4 | 3 | 4 | 5 | 5 | 1 | 6 | 1 | 2 | 38 | 63 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Score | 184 | 118 | 57 | 105 | 81 | 126 | 17 | 177 | 55 | 77 | | 76 |
| No. of Question | 10 | 9 | 3 | 6 | 5 | 7 | 1 | 10 | 3 | 6 | Average | |
| Average | 84 | 60 | 86 | 80 | 74 | 82 | 77 | 80 | 83 | 58 | | (Good) |

Based on Table 2 above, teachers generally have good grades. Indicators A, C and I have the highest pedagogical mastery values. In indicator A, controls the characteristics of learners from the aspect of physical, moral, social, cultural, emotional, and intellectual well, with the average value of 84. According to Asmani (2009), teacher capable of mastering the characteristics of students that teachers understand the characteristics that exist in students, teachers can get a picture of the initial abilities and types of experiences students have , teachers can also know the growth, development, mastery, knowledge and attitudes that inspire students, then the teacher can find out the background of students' social culture. In indicator C, developing curriculum related to the subjects/areas of development that are being taught, with an average grade of 86. According to Thaib and Siswanto (2015), curriculum management is intended so that the educational process that will take place in schools can be directed and systematically coordinated to achieve educational goals that have been set. So also the indicator I, m emanfaatkan the assessment and evaluation for the sake of learning, with an average value of 83 .According to QCA (2003) in Arifin (2014), feedback is the mean by which teachers enable children to close the gap in order to take learning forward and improve children's performance. Feedback can be used as a tool for teachers to help students so that learning activities become better and improve performance.

While indicators B and J are indicators that have the lowest values and are included in the sufficient category. Indicator B, the teacher is still unable to master the theory of learning and the principles oflearning that educate, with an average value of 60. One example of the use of various learning theories can be a guide for teachers is to determine the direction of learning. This was done to develop the full potential of learners and guide teachers to perform pembelaj a ran according to the characteristics of learners. While the indicator J, teachers also have not been able to m elakukan reflective acts for the improvement of the quality of learning , with an average value of 60 . The ability of teacher to reflect the implementation of learning is a very important skill to develop. By reflecting, pondering, and analyzing what has been done and its influence will be able to find the strengths and weaknesses of the implementation of learning.

*Content Knowledge* (CK)

Based on the analysis of the data, a *Content Knowledge* (CK) chemistry teacher's profile in Semarang is presented in table 3.

**Tabel 3.** Distribution Content Knowledge Score

| No. | Guru | *Content Knowledge* | | | | | | | | | | Skor | Persentase (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| 1 | TRS | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 | 100 |
| 2 | PNI | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 | 100 |
| 3 | RAD | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 | 100 |
| 4 | RTA | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 9 | 90 |
| 5 | DVY | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 9 | 90 |
| 6 | SUW | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 9 | 90 |
| 7 | EST | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 9 | 90 |
| 8 | AHM | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 8 | 80 |
| 9 | NNK | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 8 | 80 |
| 10 | SRI | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 8 | 80 |
| 11 | FMS | 1 | 0 | 1 | 1 | -1 | 1 | 1 | 0 | 1 | 1 | 8 | 80 |
| 12 | NTL | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 8 | 80 |
| 13 | SHF | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 8 | 80 |
| 14 | NKM | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 8 | 80 |
| 15 | AGF | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 8 | 80 |
| 16 | UNG | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 8 | 80 |
| 17 | FRD | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 8 | 80 |
| 18 | AND | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 7 | 70 |
| 19 | AYK | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 7 | 70 |
| 20 | IKA | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 7 | 70 |
| 21 | NVL | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 7 | 70 |
| 22 | IND | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 7 | 70 |
| Jumlah skor | | 22 | 15 | 20 | 20 | 19 | 14 | 17 | 16 | 17 | 21 | Rata-rata | 82 |
| Jumlah soal | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | |
| Rata-rata | | 100 | 68 | 91 | 91 | 86 | 64 | 77 | 73 | 77 | 95 | | (Very Good) |

The distribution of the concept mastery scores shows the concept knowledge of each teacher in each concept in chemical stoichiometry, and in general the teacher is already good in understanding the concept. The highest scores on questions number 1 and 10, each have a score of 100 and 95. The teacher is able and very good at determining the levels of elements in compounds and interpreting the basic laws of chemistry. However, questions number 2 and 6 have a low score of 68 and 64. There are 7 teachers who still cannot answer correctly on questions number 2, namely teachers IND, IKA, AND, FRD, NTL, FMS, and AHM. The teacher is still having trouble analyzing the levels of substances needed to produce certain amounts of substances as the application of stoichiometric equations. Whereas in question number 6, there were 8 teachers who were still unable to interpret the number of substances needed to produce a certain number of substances as the application of stoichiometric equations, namely NVL, IKA, AYK, AND, FRD, AGF, SRI, NNK, and AHM teachers.

The two questions that have the lowest average value are a form of the application of the stoichiometric equation. Many opinions say that

chemical calculation material (stoichiometry) is more emphasized on solving mathematical problems (algorithmic). But in the matter of chemical calculations not only are required to be able to complete the chemical count alone, but also must connect the basic concepts that have been obtained previously and apply them in the concept of chemical calculations. This was supported by BouJaoude and Barakat in Kind (2004) who stated that students' mathematical expertise also contributes to their difficulties. A student who cannot manipulate numbers readily is unlikely to be successful in learning about moles. This makes the material chemical calculations is not an easy matter for the calculation of material chemistry is a complex matter, complicated, and in solving problems - about chemical calculations many pitfalls. If students do not understand this material well, then students will experience many difficulties.

**Pedagogical Content Knowledge (PCK)**

Based on data analysis, the Pedagogical Content Knowledge (PCK) profile of vocational chemistry teachers in Semarang is presented in table 4.

**Tabel 4.** Description of PCK Chemistry Teacher

| No. | Teacher | *Pedagogical Content Knowledge* | | | | | PCK | Criteria | PK | CK |
|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | | | | |
| 1 | RAD | 4 | 4 | 4 | 4 | 4 | 4 | Examplary | 80 | 80 |
| 2 | PNI | 4 | 4 | 4 | 3 | 4 | 4 | Examplary | 87 | 100 |
| 3 | AHM | 4 | 3 | 4 | 3 | 3 | 3 | Developing | 63 | 80 |
| 4 | DVY | 3 | 3 | 4 | 3 | 4 | 3 | Developing | 80 | 80 |
| 5 | NKM | 3 | 3 | 4 | 3 | 3 | 3 | Developing | 83 | 90 |
| 6 | EST | 4 | 3 | 3 | 3 | 3 | 3 | Developing | 78 | 100 |
| 7 | IND | 3 | 3 | 4 | 3 | 2 | 3 | Developing | 65 | 70 |
| 8 | AYK | 3 | 3 | 3 | 3 | 3 | 3 | Developing | 78 | 70 |
| 9 | AGF | 3 | 3 | 3 | 3 | 3 | 3 | Developing | 72 | 80 |
| 10 | IKA | 4 | 2 | 3 | 3 | 3 | 3 | Developing | 83 | 70 |
| 11 | NTL | 3 | 3 | 3 | 3 | 3 | 3 | Developing | 72 | 80 |
| 12 | NVL | 3 | 3 | 3 | 3 | 3 | 3 | Developing | 77 | 80 |
| 13 | SRI | 2 | 3 | 4 | 3 | 3 | 3 | Developing | 72 | 100 |
| 14 | UNG | 3 | 3 | 4 | 2 | 2 | 3 | Developing | 82 | 80 |
| 15 | TRS | 3 | 3 | 3 | 3 | 3 | 3 | Developing | 73 | 90 |
| 16 | RTA | 3 | 3 | 3 | 2 | 3 | 3 | Developing | 85 | 90 |
| 17 | FMS | 2 | 3 | 3 | 3 | 3 | 3 | Developing | 70 | 80 |
| 18 | FRD | 3 | 2 | 3 | 3 | 3 | 3 | Developing | 67 | 80 |
| 19 | NNK | 3 | 3 | 2 | 3 | 2 | 3 | Developing | 77 | 80 |
| 20 | SUW | 3 | 2 | 3 | 2 | 3 | 2 | Basic | 88 | 90 |
| 21 | AND | 2 | 2 | 3 | 2 | 3 | 2 | Basic | 63 | 70 |
| 22 | SHF | 2 | 2 | 2 | 3 | 2 | 2 | Basic | 67 | 70 |
| Conclusion | | 3 | 3 | 3 | 3 | 3 | 3 | Developing | 76 | 82 |

In Table 4 above is a description of the PCK category of each chemistry teacher on the concept of chemical stoichiometry. There are 2 teachers who are in the "examplary" category, namely PNI and RAD. PNI have very good mastery of content, and have very good

pedagogical knowledge. RAD have good knowledge of content and pedagogy. That is, content knowledge is balanced by good pedagogical knowledge, so that the teacher is in the examplary category .

A total of 17 teachers are in the category of "developing" teachers. For example of FRD teachers, has low pedagogical mastery but is balanced with good content, so that FRD teachers are in the developing category . However, based on the PCK results of the teacher in Table 4 it is seen that it is not enough to master good content knowledge to create meaningful and effective learning, but also good pedagogical knowledge is needed. Teachers with strong content knowledge have the advantage that they are more concerned with the conceptual difficulties faced by their students (Halim and Meerah, 2002). It shows that content knowledge is a very important part of learning.

While from the results of the PCK, there are only 3 teachers in the "basic" category, namely SUW, AND and SHF teachers. AND and SHF teachers have low pedagogic and content knowledge while SUW teachers have good pedagogic and content knowledge score, but PCK SUW teachers are only able to place in the *basic* category. This proves that good pedagogical and content knowledge do not guarantee teacher's PCK ability is also good. This is in line with research conducted by Kind (2009), showing that teachers with good content knowledge are not guaranteed to produce effective learning. So, to build PCK knowledge is not only emphasized on content knowledge but with pedagogical knowledge and balanced with teaching experience so that the knowledge and experience can be integrated into a whole knowledge called PCK.

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## CONCLUSION

Overall, teachers already have a good pedagogical and content knowledge. Each teacher in the chemical stoichiometry content has a different PCK category, there are 2 teachers who are in the examplary category, namely RAD and PNI teachers. A total of 17 teachers who are in the developing category. As many as 3 teachers who are in the basic category, namely SUW, AND, and SHF. There are no teachers in the limited category. From the results of the PK, CK, and PCK analysis it was found that teachers who had good content tended to have PCK abilities that were in the developing and examplary categories. However, there was one research subject who had good content and pedagogical skills but had PCK abilities that were at basic category.

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