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Actualization Pedagogical Content Knowledge (PCK) of Novice Teachers in Learning Practice at Systems of Linear Equations of Two Variables (SPLDV)

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***Abstract*—** Pedagogical Content Knowledge (PCK) is a blend of content knowledge and pedagogical knowledge that teachers use to convey certain material to make it more easily understood by students. PCK components include: knowledge of teaching, knowledge of students, and content knowledge. Research of PCK on previous study more focus on the knowledge of teachers and little has been linked with learning practice of teacher in the classroom. Therefore, this study will analyze the PCK and actualization in classroom practice. This study aims to investigate the description of PCK and learning practice of novice teachers who teach mathematics at SPLDV material. PCK and learning practices comparison is based on the position of teacher PCK level compared to the level of learning practices. The approach used in this research is descriptive qualitative approach. The participants in this study were two novice teachers (teaching experience less than 3 years), with details of the first participant is already certified novice teachers through professional education of teachers (PPG) and the second participant of novice teachers who have not been certified. The results of this research in general are: (1) the PCK and learning practice level of first participant are constant; (2) the PCK and learning practice level of second participant are changed.

Keywords: *Pedagogical Content Knowledge, learning practice, Systems of Linear Equations of Two Variables*

I. INTRODUCTION

Education hold an important role in the development and progress of a nation. One of the factors that determine the success of the education is the teacher (both as educators and teachers). As stated in UU No. 14 year 2005, the teachers are required to master four competencies, namely: pedagogical, professional, social, and personality. In the last 2 decades much research done on the first two competencies, namely pedagogical and professional. In general, researchers use the term Pedagogical Content Knowledge (PCK), which was first introduced by Lee Shulman in 1986. PCK is composed of two major parts of Pedagogical Knowledge and Content Knowledge.

PCK become an issue once new ideas to maximize the learning process and results, particularly in mathematics. Evidence from the field suggests that teachers of mathematics in general can be categorized into four groups, namely: (1) teachers with content knowledge and pedagogical knowledge was good; (2) teachers with good content knowledge, but have less pedagogical knowledge; (3) teachers with less content knowledge, but have a good pedagogical knowledge; and (4) teachers with content knowledge and pedagogical knowledge is lacking. Ideally a teacher into the group (1), but in fact a lot that can not be categorized into the group. By analyzing the teacher's PCK, is expected to be obtained by a consideration of information for education policy makers in the design of in-service training for teachers and pre-service training for prospective teachers.

PCK is described as a result of the integration between the understanding of teaching materials (content knowledge) and understanding the way of educating (pedagogical knowledge) that need to be

owned by a teacher. Shuell and Shulman (in Eggen and Kauchak, 2007) argued that PCK is an understanding of effective learning methods to explain the specific material, as well as an understanding of what makes a particular material is easy to learn. So to be effective teachers is not enough just to have knowledge of the material (content) or pedagogical knowledge is good, but should be able to combine both in instructional practices.

Several studies of PCK among which are: 1) Speer & Wagner (2007), which concluded that the PCK and Specialized Content Knowledge (SCK) required of teachers in providing scaffolding analytic discussion process; 2) Turnuklu & Yesildere (2007) found a relationship between mathematics knowledge and PCK; 3) Margiyono & Mampow (2010) describe the PCK into seven components measured namely: (a) the knowledge of students, (b) mastery of curriculum standards, (c) mastery of the learning process, (d) knowledge of evaluation, (e) knowledge about teaching resources, (f) knowledge of the matter and (g) knowledge of the learning objectives. While Karahasan (2010) in his research describing the characteristics of PCK prospective teachers.

Several studies of PCK is still rare that examines the PCK actualization of teachers in the practice of learning in the classroom. Therefore in this study will be assessed PCK teachers associated with the learning practice in the classroom. Practice is considered the "action", "deed" or "behavior" (Ponte and Chapman, 2008). Saxe (1999: 25) argues the practice as a social event that is repeated in daily life. According to Simon and Tzur (1997) the practice is seen as what is done, it is known, trusted, and desired by the teacher. The practice of teachers as the unity of the faith, questions, or mathematical knowledge can not be understood in isolation. (Simon and Tzur, 1997: 160).

From the above description, researchers want to know Pedagocical Content Knowledge (PCK) Novice mathematics Teachers and learning practices in the classroom through research entitled: "Actualization Pedagogical Content Knowledge (PCK) of Novice Teachers in Learning Practice at Systems of Linear Equations of Two Variables (SPLDV)".

II. THEORETICAL FRAMEWORK

A. Pedagogical Content Knowledge (PCK)

PCK is knowledge of certain teaching materials that require knowledge and pedagogical content together. Shulman (1986) was the first to introduce the term pedagogical content knowledge. He described PCK as an understanding of how topics and strategies in specific participant areas are understood and misunderstood (Shulman, 1986). Carpenter, et al. (1988: 386) describes the PCK as: conceptual knowledge and procedural knowledge, understanding of the conceptions and misconceptions about a topic, and stages of understanding of students. PCK also include knowledge of techniques to assess student understanding and diagnosing their misconceptions, knowledge of learning strategies that can be used to connect what they learn with the knowledge that already have, and knowledge of instructional strategies to eliminate their misconceptions. PCK involves knowledge of content and students, as well as knowledge of the content and teaching.

The general belief in the community is if math teachers know math very well, he is the best person to teach mathematics. But what if the teacher does not have the knowledge to teach math? Both of them should be owned by teachers as complementary to each other. Fennema and Franke (in Turnuklu & Yesildere 2007) determine the components of teacher knowledge of mathematics as follows: (1) Knowledge of mathematics in the form of content knowledge, include: the nature of mathematics and science teachers' mental organization; (2) knowledge of the mathematical representation; (3) knowledge of students, such as students' knowledge of cognition; and (4) knowledge of teaching and decision making.

The first item is about conceptual understanding of mathematics. Fennema and Franke (1992) argues that if the teacher has a conceptual understanding of mathematics, it will affect classroom teaching, because it is important for teachers to have knowledge of mathematics. They also stressed the importance of representation of mathematical knowledge, because mathematics is seen as the composition of a large set of abstractions that are interrelated. If the teacher does not know how to translate abstractions into a form that allows learners to connect mathematics with what they already know, they will not learn with understanding (meaningful learning).

Knowledge of cognition of students seen as one of the important components of the teacher's knowledge, since according to Fennema and Franke (in Turnuklu & Yesildere, 2007), learning is based on what happens in the classroom, thus, not only what students can do, but the neighborhood also important in learning. The final component of the teacher's knowledge is knowledge about teaching and

decision-making. Teacher beliefs, knowledge, judgment, and mind influence the decisions they make that affect their plans and actions in the classroom (Fennema and Franke, 1992).

Knowledge of mathematics and mathematical representations of knowledge related to content knowledge, while the students' knowledge and knowledge about teaching related pedagogical knowledge. Shulman (1995) defines content knowledge as knowledge of the subject, such as mathematics and structure. According to Shulman (1995: 130) PCK includes means representing and formulating the subject that make it easy to understand other people.

Pedagogical content knowledge (PCK) is seen as the blending of content and pedagogical into an understanding of how particular topics, problems, or issues are organized, represent, and adapted to the diverse interests and abilities of learners, and presented for instruction (Shulman, 1987). PCK is described as a result of the integration between the understanding of teaching materials (content knowledge) and understanding the way of educating (pedagogical knowledge) that need to be owned by a teacher. Shuell and Shulman (in Eggen and Kauchak, 2007) argues that PCK is an understanding of effective learning methods to explain the specific material, as well as an understanding of what makes a particular material is easy to learn.

Based on the Shulman idea (1987) on PCK, teachers can have a profound knowledge of how to teach the participant matter to students (Parker & Heywood, 2000). Shulman (1987) also states that the PCK must include knowledge of learners and their characteristics, knowledge of the context of education, knowledge of the purpose and values of education and basic philosophical seta their history. Additionally, PCK refers to the ability of teachers to transform content into forms that are pedagogically very powerful and yet adaptive to students' varying abilities (Shulman, 1987).

According to An, et al. (2004) PCK has three components: 1) Knowledge of content, 2) Knowledge of curriculum, and 3) Knowledge of teaching. An et al. (2004) also shows the importance of knowledge about teaching and they accept it as a core component of PCK. In short, as the opinion Grouws and Schultz (1996) PCK includes representation that is useful, unifying ideas, clarifying examples and counter examples, analogies help, important relationships, and relationships between ideas. According to some opinions above PCK researchers divided into three components, namely: 1) Knowledge of Teaching, 2) Knowledge of Students, and 3) Content Knowledge. Furthermore, to analyze PCK participant, the researchers used a modified framework of Karahasan (2010).

B. Learning Practice

In some studies the practice is regarded as the "action", "deed" or "behavior" (Ponte and Chapman, 2008). According to Simon and Tzur (1997) the practice is seen as what is done, it is known, trusted, and desired by the teacher. The practice of teachers as a union that can not be understood only see part of the whole, ie only see convictions, questions, or knowledge of mathematics course. (Simon and Tzur, 1997: 160). Skott (1999) emphasized the importance of the study of the reasons of teacher practice. Saxe (1999: 25) argues the practice as a social event that is repeated in daily life. A key assumption is that there is a relationship between the activities and practices of the reflective individual, because the practice of giving form and meaning in the social activities of individuals. Boaler (2003: 3) describes the practice as a repetitive activity and norms developed in the classroom from time to time, in which teachers and students involved. Boaler and Saxe common ground is the idea of stability and repeatability of practice. However, Saxe emphasized their socially organized and Boaler considers not only activity but also the norm.

If the study of practices considered as an activity, repetition, social setting and knowledge, meanings and motives of the participants, the teacher practices can be seen as the activities they perform on a regular basis, taking into account the work context, meaning and their purpose. This includes the social structure of the context and the various layers of the class, school, community, professional structures and education and social systems. But this can cause problems, as noted by Events and Schwartz (2002), which addresses the issue of interpretation of teacher practice and its implications for research. The results showed that each was given a theoretical framework are likely to bring these types of questions and the different images of different situations. Practice is too complex to be understood by one perspective alone, but by combining several theoretical approaches may be an interesting suggestion, it can enhance the legitimacy of the questions that must be addressed by researchers.

In this study teacher learning practices will be analyzed based framework used to analyze the PCK in the previous section. So it will be seen comparison between PCK owned novice teachers with learning practice in the classroom.

III. METHOD

This study used a descriptive qualitative approach. Participants consisted of 2 novice teachers with details: 1 teacher with 3 years teaching experience and has been a certified educators through professional education of teachers (PPG) and one teacher with 3 years teaching experience and do not have a teaching certificate. Data taken in this study are: (1) vignette, CoRe and PaP-eRs to portraying PCK teacher, and (2) video instructional practices, to portraying the learning practices of teachers. While the analysis include: data reduction, data presentation, and conclusion. PCK is used to analyze the modification framework Karahasan (2010) and for the analysis of instructional practices of teachers also used the same framework. To ensure the validity of the data in this study, used a technique criteria degree of confidence (credibility), namely: (1) persistence of observation, (2) triangulation, and (3) checking peers (Moleong: 2012: 327).

IV. RESULT AND DISCUSSION

A. Participant 1 (initials DA)

1. Description of PCK participant DA

a. Knowledge of Teaching

In the knowledge of teaching component, the participant of DA has been trying to construct meaning and understanding to students, for example, to understand the meaning 0 = 1, and 0 = 0 on the outcome of the elimination or substitution of the students are asked to draw a graph of the SPL, so that will be visible position of the two lines (vignette 2 and vignette 3). But in naming the conceptual knowledge needed in studying this material DA could not say with detailed and precise (CoRe 5a). As related to his role as assessor and a reminder, the participant of DA has been able to assess the results of the students' work, although not consistently (vignette 1 and vignette 5), but it also has to use assessment tests through a quiz or a daily test and non test through observation of student performance (CoRe 8). While the mention of learning steps DA has not been mentioned in detail and sequence of how learning steps that should (CoRe 6a), but DA has been able to write an experience for teaching SPLDV how should the graphical method presented, ie, before the student can draw a graph PLDV, then SPLDV graph drawing is not given in advance. Based on the description then generally it can be said that the knowledge of the participant taught DA is at "level 2".

b. Knowledge of Learners

Participant DA has done a diagnosis of students' mistakes (vignette 4, 5, 6, CoRe 7), but often are not able to explain the solution. For example, when students multiply the linear equation by 0, DA could be a decisive step was wrong, but could not specify why the step one (vignette 4). Besides DA can determine the position of the mistakes made by students during the linear equation multiply by 3 (vignette 5), but when asked to write down the correct answer DA also make mistakes count. While in facilitating students to solve problems, DA demonstrated well, for example to guide students in solving SPLDV, if it produces 0 = 1 atau 0 = 0 when eliminated or substituted then it is suggested to use graphics (vignette vignette 2 and 3). As in formulating learning objectives (CoRe 1), DA has been able to formulate objectives SPLDV quite well, whereas in explaining the importance of the conveyed material (CoRe 2) most needs to be improved. Further associated with learning resources (CoRe 6b) DA has not been able to identify the source of learning in addition to books and worksheets, for example, the classroom environment, internet, home environment, libraries, and others. Therefore, in general it can be concluded that students' knowledge of the participant DA is on the "level 1".

c. Content Knowledge

Participant DA in general form PLDV states, not to mention the condition completely, so that in response to the case of the form $0x + 0y = 0$ (vignette 4) have not been able to explain it well. Participant DA also less appropriate analogy about the story into a variable, so that when students write analogy x = notebooks and y = pencils participant considers the analogy is appropriate (vignette 1). As for the mention of procedural knowledge required in the SPLDV DA well enough to be able to mention. Likewise, the participant is good enough to use a graphical representation (vignette 2 and vignette 3), which provides an explanation for the case 0 = 1 approach charts. On the other hand, the participant DA could not say exactly material necessary prerequisite to the concept of principal PLDV, SPLDV, and completion SPLDV (CoRe 4). So in general content knowledge of the participant is still at the "level 1".

2. Description of Participant DA Learning Practice

a. Practice of Knowledge or Teaching

In general, the practice of knowledge of teaching participants DA is enough good. It can be seen from coherently learning steps, compliance RPP with learning, and use of the proper allocation of sufficient time. DA has also been trying to create learning that enable students. This can be seen when explaining the material SPLDV, DA only explained globally, the rest students are asked to discuss with the group of their friends. But if there is material that the students feel elusive, the DA also provide a more detailed explanation, for example, when describing the graphical method looks DA explained with sufficient detail so that it looks students really understand. At the time of giving explanations material, DA also keep trying to engage students, such students are invited discussion to identify examples and are not examples PLDV, terms SPLDV, and the possibilities of settlement SPLDV.

In questioning and discussion techniques, DA tried to give the widest opportunity for students to present any given task and provide the opportunity for other students to argue or comment if there are less fit their ideas. DA gives strength after no more students who commented on the presentation of the students' answers. There are things that need to be improved from the practice of knowledge of teaching participant DA, ie: not using instructional media and learning resources are used only as worksheets and textbooks. The assesment technique used DA are the observation of student activity and giving a quiz. At the end of the lesson DA invites students to conclude that the material being studied. Of such exposure could be concluded that the practice of knowledge of teaching participant DA is at "level 2".

b. Practice of Knowledge of Learners

Practice of Knowledge of Learners participant DA also looks very good. This is indicated by always around to observe student work as well as providing assistance if there are students who feel confused or have problems as long as the students do the work. In addition, each student opinion given is always appreciated by DA although these opinions may be less precise. In communicating with students DA also looks pretty good, which it is visible when DA explain to the class as well as provide an explanation when DA around watching the student's work. DA capability in engaging students in learning process is also very good, as seen during the learning DA reduced role as a demonstrator, but more often to facilitate and assist students in learning. Therefore, the general practice of Knowledge of Learners participant DA can be categorized into the "level 3".

c. Practice of Content Knowledge

In identifying the concept PLDV and SPLDV, DA has been demonstrated knowledge and ability is quite good, in addition to clarify the concept of DA provides an illustration in the form of examples and not an example. Besides DA also provide an example that requires students to think at a higher level, for example, students were told to determine whether the equation $xy + y = 3$ is PLDV or not. But the analogy, participant DA still made some mistakes such as when students write analogy m = mango, and a = apple, DA only provide a response that is true is a = 1 kg of apples, m = 1 kg mango. Whereas the correct analogy is a = price of 1 kg of apples, m = the price of 1 kg of mango. But in other cases DA has determine a precise analogy. Besides DA also uses charts to clarify the interpretation solution of SPLDV. So in general it can be concluded that the practice of the content knowledge participant DA is at "level 2".

3. Comparison of PCK and the learning practice Participant DA

To determine the comparison of PCK and learning practices participant DA, then presented comparative analysis of PCK and learning practices as table 1 below.

Table 1 Comparison of PCK and Learning Practice Participant DA

Component of PCK	Level	Component of Learning Practice	Level	Comparison
Knowledge of Teaching	Level 2	Practice of Knowledge or Teaching	Level 2	Costant
Knowledge of Learners	Level 1	Practice of Knowledge of Learners	Level 3	Changed
Content Knowledge	Level 1	Practice of Content Knowledge	Level 2	Changed

Based on Table 1 above, seen that DA can be inferred that from the three components of PCK, level of knowledge of teaching and practice of knowledge of teaching are constant, which is at level 2. According Karahasan (2010) characteristics of the knowledge of teaching at this level in general is to

facilitate and guide the students rather than provide answers and explanations, assess student understanding broaden this understanding with knowledge questions mathematical further assess students' interaction with students, reward and encourage students to construct knowledge of mathematics through inquiry math, sort of topics and questions in an appropriate manner, as well as control class so create a learning environment that is democratic.

As for the components of knowledge of students and content knowledge between PCK and learning practice have level changes. Changes here seen that during the teaching practice, DA can show knowledge of learners and knowledge of content better than PCK through writing instrument. The development of the participant PCK of participant DA during teaching practice is influenced by prior educational background, where after graduating S-1 mathematics education courses, the participant of DA follows the Professional Teacher Education (PPG) during the second semester. According to Hudson (2007) pedagogical knowledge is strongly influenced by the lectures, field work, and mentor through undergraduate studies.

B. Participant 2 (initials AW)

1. Description of PCK participant AW

a. Knowledge of Teaching

Participant AW have been trying to build meaning and understanding to students, for example, to understand the meaning 0 = 1, and 0 = 0 on the outcome of the elimination or substitution of the students are asked to write down the results of the example as $0y = 1$ and $0y = 0$ (vignette 2 and vignette 3). From the form of the expected students can find relevant conclusions SPLDV solution. Besides the participant AW also has another explanation alternative is to use charts. As for the mention of conceptual knowledge required in studying this material AW could mention although still not detailed (CoRe 5a). As related to his role as assessor and a reminder, the participant AW have been able to assess the results of the students' work very well (vignette 1 and vignette 5), but it also has to use assessment tests through quizzes and non test through observation when students discuss (CoRe 8). Likewise, learning steps already prepared a detailed and sequential and reflect the learning activities that enable students (CoRe 6a). Participant AW also strive to improve the learning SPLDV, which at the first AW for teaching the lecture course there are many students who feel bored and less active in learning. But after next year AW change his method of discussion, the students become more active and increase learning motivation. Based on the description then generally it can be said that the knowledge of teaching participant DA is at "level 2".

b. Knowledge of Learners

Participant AW has been able to diagnose the mistake made by student (vignette 4, 5, 6, and CoRe 7), and able to explain the solution. For example AW can determine the position of the mistakes made by the students at the time of multiplying the number of linear equations with three (vignette 5), and can explain how the answer should be. Likewise in facilitating students to solve problems, AW demonstrated well, for example to guide students in solving SPLDV, if it produces 0 = 1 or 0 = 0 at the time eliminated or substituted, the students are asked to write down the results of the example as $0y = 1$ and $0y = 0$ (vignette 2 and vignette 3). As in formulating learning objectives (CoRe 1), AW has been able to formulate objectives SPLDV quite well, whereas in explaining the importance of the materials submitted (CoRe 2) most needs to be improved. Further associated with learning resources (CoRe 6b) AW has been able to identify the source of learning in addition to books and worksheets, for example internet. based on the description in general can be concluded that knowledge of learners of participant AW are at "level 2".

c. Content Knowledge

Participant AW in understanding the requisite of general form of PLDV, the confusion between the words "not both zero" with the word "both are not zero". Likewise in addressing the analogy x = notebooks and y = pencils AW considers the analogy is not quite right, but the participant let the student make the analogy because it is not considered a significant error (vignette 1). Participant AW also considers $0y= 1$ is equivalent to $y = 1/0$ and $0y = 0$ is equivalent to $y = 0/0$. On the other hand AW has been able to mention the material prerequisites for the material SPLDV although it is limited. As for the mention of procedural knowledge required in SPLDV participant DA well enough to be able to mention. So in general content knowledge of the participant is still at the "level 1".

2. Description of Participant AW Learning Practice

a. Practice of Knowledge of Teaching

In lessons, participant AW have tried to create a coherent teaching, although it is still not optimal. For example in initiating SPLDV material, participant AW deliver learning objectives to be achieved and also write down the main points of the material the students will learn sequentially. In addition AW also use questioning and discussion well. It is seen during learning, AW is a lot of discussion and question and answer session with the students rather than explaining the lecture method. The assessment used is the assessment process, namely through the observation of performance (activity) students in the group and at the time of presentation. At the end of the learning AW also has to do reflections by providing reinforcement to riviews and invites students to conclude that the material being studied. So generally can be inferred from the practice of knowledge of teaching participants AW is at "level 2".

b. Practice of Knowledge of Learners

During learning, AW is often seen helping students to understand and solve problems SPLDV. AW using readily accepted explanation for the students, such as students' confusion getting results 0 = 1, AW asks the students to write $0y = 1$ as another form of 0 = 1, so that students can determine the completion of SPLDV asked. AW also seen frequently engaging students in learning, for example, students were invited together to identify the characteristics PLDV and SPLDV. Additionally, when students asked about the difficulties facing certain problems, AW did not directly answer, but it gives students the opportunity to think independently used while providing modest support (scaffolding). It can therefore be concluded that the practice of Knowledge of Learners of participant AW is at "level 3".

c. Practice of Content Knowledge

Actually, the participant AW have shown good enough content knowledge for teaching practice. But occasionally seen AW still do not understand the proper use of notation. This is for example evidenced by allowing just the students who wrote the set of solution in many ways, namely: (2,1), {2,1}, and {(2,1)}. In addition AW also allow students who write $x = \infty$ and $y = \infty$ as a form of invfinitely solution. Similarly, when explaining $0y = 0$, AW considers equivalent to y = 0/0, and stated 0/0 = 5, 0/0 = -100, 0/0 = 1/70. Therefore, the practice of content knowledge participant AW is still at the "level 1".

3. Comparison of PCK and the learning practice Participant AW

To determine the comparison PCK and learning practices participant DA, then presented comparative analysis of PCK and learning practices as table 2 below.

Tabel 2 Comparison of PCK and the learning practice Participant AW

Component of PCK	Level	Component of Learning Practice	Level	Comparison
Knowledge of Teaching	Level 2	Practice of Knowledge or Teaching	Level 2	Costant
Knowledge of Learners	Level 3	Practice of Knowledge of Learners	Level 3	Costant
Content Knowledge	Level 2	Practice of Content Knowledge	Level 1	Changed

Based on Table 2 above can be inferred from three components of PCK, level of knowledge of teaching and knowledge of the learners constant between PCK with learning practices. This is in accordance with the opinion of Li (2009) that PCK mathematics teachers have an impact on the teaching they do is apparent not only from the object of teaching, structure of teaching, and the idea of explaining, but also from the view of education, emotional teaching, teaching design, teaching language, thinking math student, the student's learning attitude and so on.

As for the component content knowledge between PCK with learning practices level changes. Changes here seen that during the teaching practice, the content knowledge that is shown not as good AW PCK through writing instrument. This is due to the experience of teaching the participant of the new AW 2 years, so the possibility of improvisation during instructional practices are still lacking. According Gatbonton (2008) a group of experienced teachers have the pedagogical knowledge that is more detailed, particularly in regards attitudes and behavior of students.

V. CONCLUSION

The results of this study indicate that teachers in the classroom teaching practice is strongly influenced by the knowledge (PCK) about how to teach math material. In addition it was found that the quality of teaching practices are not only influenced by the teaching experience of a teacher, but also by the teachers' educational backgrounds, including education and training to improve the professionalism of teachers have been followed.

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