IOSR Journal of Research & Method in Education (IOSR-JRME)
e-ISSN: 2320–7388,p-ISSN: 2320–737X Volume 6, Issue 4 Ver. I (Jul. - Aug. 2016), PP 51-59
www.iosrjournals.org

Portraying Pedagogical Content Knowledge (PCK) of Novice Mathematics Teachers Using Vignette

Maryono[1], Akbar Sutawidjaja[2], Subanji[2], Santi Irawati[2]
[1]*Department of Mathematics Education, Institut Agama Islam Negeri (IAIN) Tulungagung, Indonesia*
[2]*Department of Mathematics, Universitas Negeri Malang (UM), Indonesia*

Abstract: *This study aimed to describe the pedagogical content knowledge of novive mathematics teachers on the material system of linear equations in two variables. The approach used is qualitative descriptive. The main instrument is the researchers themselves and the supporting instruments is a vignette and interview guides. Procedure research includes: granting vignette to the subject and continued the interview. Data were analyzed using Karahasan frameworks. The results showed that the pedagogical content knowledge of the subject 1 are knowledge of teaching, knowledge of the learners, and content knowledge they are all on level 1. As for the subject 2, knowledge of teaching and knowledge of the learners are at level 2and content knowledge is at level1.*
Keywords: *pedagogical content knowledge, system of linear equations in two variables (SLETV), vignette*

I. Introduction

The teacher's knowledge is a sufficient condition for successful learning particular material. The teacher's knowledge includes content knowledge and pedagogical knowledge. Both must be owned by a teacher well. However, the facts show that not a few teachers who have a good content knowledge but lacking in pedagogical knowledge, or otherwise have a good pedagogical knowledge but lacking in content knowledge. Ideally, a teacher must possess both the knowledge (content and pedagogical) with both at once can combine the two in instructional practices. The merger of content knowledge and pedagogical initiated by Shulman in terms of Pedagogical Content Knowledge (PCK).

According to Shulman (1986) The category of pedagogical content knowledge includes the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations and demonstration-in a word, ways of representing and formulating the subject that makes it comprehensible to others. Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult; the conceptions and preconceptions that students of different ages and backgrounds bring with them to learning of those most frequently taught topics and lessons.

While (Loughran et al., 2006) is defined the pedagogical content knowledge (PCK) of a teacher as their knowledge of content and how to teach that particular content. PCK was defined as the knowledge of, the rationale behind, planning for, and the act of teaching a piece of subject matter using specific methods for specific students to promote student learning (Gess-Newsome & Carlson, 2014). In addition, according to Abbit (2011) that PCK is knowledge of pedagogy, learning practices and lesson planning, as well as the appropriate methods to teach the material. According to Subanji (2015) PCK be the main thing for the development of teacher competence. By mastering pedagogical content at the same time, teachers will be easy to make students learning achievement maximum. This can happen because the teacher will understand how the process of knowledge construction by students.

The material system of linear equations in two variables (SLETV) given in class X Senior High School. In this material the students often have misconceptions and difficulties. For example, students are given about SLETV with infinitely many solutions, the next question is settled by the methods of elimination to produce the form 0 = 0. Students feel confusion over the meanings of these results. many say 0 = 0 indicates linear equations in two variables do not have a solution. Likewise, when given SLETV who do not have a solution, then resolved with substitution methods produce the form 0 = 1. Although students may find out that it does not have a solution but students confusion explains the meaning 0 = 1.

Some opinions are mentioned on PCK components are as follows. Shulman (1986) mentions three components of PCK: (1) knowledge of topics regularly taught in one's subject area, (2) knowledge of forms of representation of those ideas, and (3) knowledge of students' understanding of the topics. Grossman's (1990) mentions the construct of PCK includes four central components: (1) conception of teaching purposes – knowledge and beliefs about the purposes for teaching a subject at different grade levels; (2) knowledge of students, including students' understanding, conceptions, and misconceptions of particular topics in a subject matter; (3) curricular knowledge, which includes knowledge of curriculum materials available for teaching particular subject matter and knowledge about both the horizontal and vertical curricula for a subject; as well as

(4) knowledge of instructional strategies and representations for teaching particular topics. While Rollnick et al. (2008) consider the PCK an amalgam of four areas of the knowledge base for teaching. They are: a) Content Knowledge; b) Knowledge of Students; c) General Pedagogical Knowledge; d) Context Knowledge. In this study, researchers used the opinion Rollnick et al. (2008) and focus on the three components of the first with the little change in terms is for general pedagogical knowledge into the knowledge of teaching.

There are some opinions that present a framework for analyzing the characteristics of PCK teachers based on certain levels, which are as follows. Ebert (1994) states that there are three levels of PCK: Level 0: inadequate, Level 1: good, Level 2: strong. Thompson (1994) says there are three levels in the PCK, namely: Level 0, Level 1 and Level 2. Lindgren (1996) also mention there are three levels in the PCK, namely: Level 0: rules and routines (RR), Level 1: discussion and games (DG), level 2: Open Approach (OA). While Karahasan (2010) combines three such frameworks into the new framework. The description of each component and the level presented in Table 1 as follows.

Table 1. The Descriptions of Main Characteristics of PCK (Karahasan, 2010)

Components of PCK	Level 0	Level 1	Level 2
Knowledge of Teaching	- are seen as knowledge providers and demonstrators for the students - introduce procedures after concepts - dominate the flow of information that is a path between the teacher and student - have problems sequencing the topics and problems during teaching/ lesson planning - have difficulty in controlling the class to have a democratic teaching environment	- not only provide necessary rules and procedures but also help students to develop meaning and understanding - view their role as one of advising, appraising, and admonishing - still dominate the flow of information which is a path between teacher to the student - only have problems sequencing the problems during teaching/ lesson planning - sometimes controls the class to have a democratic teaching environment	- facilitate and guide students rather than provide answers and explanations - value student understanding and extend that understanding by questioning further mathematical knowledge - value student-to-student interactions - allow and encourage students to construct mathematical knowledge through mathematical inquiry - sequence the topics and problems in an appropriate way - controls the class to have a democratic teaching environment
Knowledge of Learners	- have difficulty in diagnosing errors of the students - view responding to students misconceptions as an opportunity for them to tell the student the direct rule or procedure - have difficulty in realizing students needs for understanding	- diagnosing some of the student errors and even if they address the error they focus on the surface futures of the error - solve similar numerical examples, practice problems but also appreciate the importance of discussion - from time to time realize students' needs for understanding and prepare learning environments.	- easily diagnose student errors and address students difficulties - guide and facilitate students rather than providing answers and explanations - aware of students" needs for understanding and accordingly able to create rich learning environments.
Content Knowledge	- unable to express definitions correctly - unable to use appropriate notation sensibly - use only declarative and/or procedural questions - unable to interpret and use different representations easily - face difficulty when there is a need to see connections between different topics/subunits	- express definitions correctly - use appropriate notation sensibly - still use declarative and/or procedural questions - interpret and use graphical and other representations - see connections between different topics/subunits	- express definitions correctly - use appropriate notation sensibly - use all type of questions (declarative, procedural, and conditional) in an appropriate positions - interpret and use graphical and other representations sensibly - see connections between different topic/subunits and move among them smoothly

II. Research Method

This study used descriptive qualitative approach. Participants consisted of 2 novice mathematics teachers with details: subject 1 (S1) is a mathematics teacher with 3 years teaching experience and has been a certified educators through professional education of teachers (PPG) and subject 2 (S2) is a mathematics teacher with 3 years teaching experience and do not have a teaching certificate (S2).

There are two main type of instruments used, main and auxiliary instruments. The main instruments are the researchers themselves who act as planners, data collectors, data analysis, interpreters, and reporters of research results. The auxiliary instrument used in this study is vignette and interview guides.

Vignettes are scenarios including student comments, questions, and/or solutions, and are generally used for searching PCK of teachers. There are 3 vignettes used in this study are as follows:

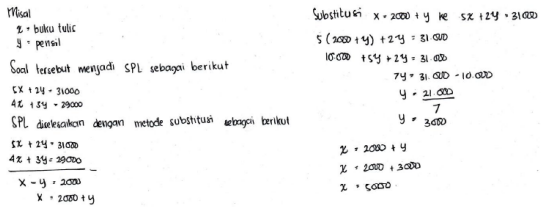
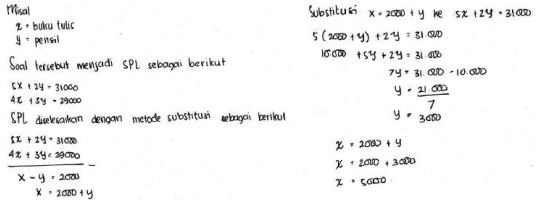
Kasus 1 Dalam suatu pembelajaran seorang guru memberikan contoh soal cerita tentang SPLDV sebagai berikut: ***Firza membeli 5 buku tulis dan 2 pensil di sebuah toko, ternyata dia harus membayar Rp. 31.000,-. Keesokan harinya Nisa membeli 4 buku tulis dan 3 pensil di toko yang sama, ternyata total harganya Rp. 29.000,-. Berapakah harga sebuah buku tulis dan sebuah pensil di toko tersebut?*** Selanjutnya guru meminta kepada siswa untuk menyelesaikan soal tersebut dengan terlebih dahulu membuat model matematika. Berikut adalah jawaban salah satu siswa bernama Ghildan:  Tuliskan komentar Bapak/Ibu terhadap jawaban Ghildan tersebut! Jika jawaban tersebut terdapat kesalahan atau kekurangan, bagaimana Bapak/Ibu memberikan penjelasan kepada siswa tentang jawaban yang tepat dari soal tersebut?	**Case 1** In a lesson of a teacher gives an example about the story about SLETV as follows: ***Firza buy 5 books and 2 pencil in a store, it turns out he has to pay Rp. 31.000, -. The next day Nisa buy 4 books and 3 pencil in the same store, it turns out the total cost Rp. 29.000, -. What is the price of a notebook and a pencil in the shop?*** The teacher asked the students to solve the problem by first making a mathematical model. Here is the answer to one of the students named Ghildan:  Add a Your comment to Ghildan answer! If the answer is there are errors or deficiencies, how to briefed the students on the correct answer of the question?

Figure 1 Vignette Case 1

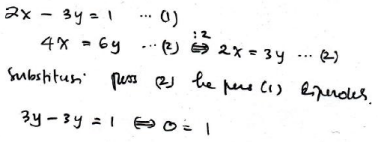
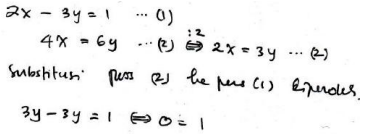
Kasus 2 Seorang guru memberikan soal tentang SPLDV, yaitu: selesaikan $\left.\begin{matrix} 2x-3y=1 \\ 4x=6y \end{matrix}\right\}$. Salah satu siswa bernama Zidni menyelesaikan dengan metode substitusi sebagai berikut:  Zidni mengalami kebingungan ketika mendapatkan hasil 0 = 1. Bagaimana Bapak/Ibu memberikan penjelasan kepada siswa terkait penyelesaian SPL ketika didapatkan hasil 0 = 1 seperti kasus tersebut?	**Case 2** A teacher gives a matter of SLETV, namely: complete 2x-3y = 1 and 4x = 6y. One student named Zidni completing the substitution method as follows:  Zidni experienced confusion when getting results 0 = 1. How is you provide an explanation to the students related to the completion of the SPL when the results obtained 0 = 1 as is the case?

Figure 2 Vignette Case 2

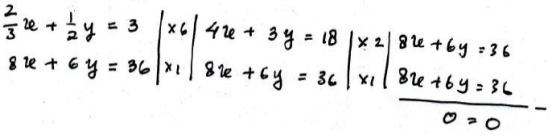
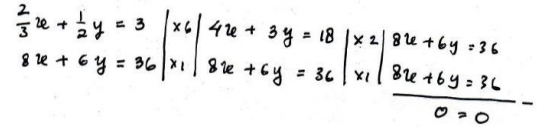
Kasus 3 Seorang guru memberikan soal tentang SPLDV, yaitu: selesaikan $\left.\begin{matrix} \frac{2}{3}x+\frac{1}{2}y=3 \\ 8x+6y=36 \end{matrix}\right\}$. Salah satu siswa bernama Affan menyelesaikan dengan metode eliminasi sebagai berikut:  Affan mengalami kebingungan ketika mendapatkan 0 = 0. Bagaimana Bapak/Ibu menjelaskan makna dari hasil 0 = 0 tersebut kepada siswa?	**Case 3** A teacher gives a matter of SLETV, namely: complete 2/3x+1/2y = 3 and 8x + 6y = 36. One student named Affan completing the elimination method as follows:  Affan experienced confusion when getting results 0 = 0. How is you provide an explanation to the students related to the completion of the SPL when the results obtained 0 = 0 as is the case?

Figure 3 Vignette Case 3

The procedures in this study include: subject fill the vignette and then interview to clarify the subject written response to the vignette. Activity in qualitative data analysis performed interactively and runs continuously until complete, so that the data is already saturated. Activities in the data analysis, namely data reduction, data presentation, and verification/conclusion.

III. Result And Discussion

Here is presented the results of research on the pedagogical content knowledge of beginning teachers on the material system of linear equations in two variables.

Subject 1 (S1)
Vignette case 1

Here is the response of S1 in a vignette case 1

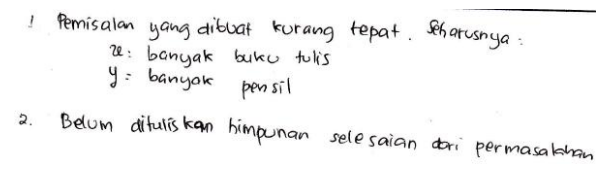
	1. *made less appropriate analogy, it should be x: number of books, y: number of pencils* 2. *set of solution of the problem has not been written*

Figure 4 Response of S1 in vignette case 1

The response given is seen that S1 considers analogy of the student is still not quite right, but the analogy is correct according to the S1 also still not right (as seen in the response above). If x = the number of a notebook and y = the number of a pencils, the solution is given not answer the questions given. On the matter of the question is the price of a notebook and a pencil. So the more appropriate analogy is x = the price of a notebook and y = the price a pencil. S1 response given is also reinforced by the results of the interview excerpts below:

R	:	*How do you think the answers are written Ghildan in such cases?*
S1	:	*Yesterday I look, I think the answer is correct but the analogy is done is still not quite right. It says x = books and y = pencils. Supposedly x = the number of books and y = the number of pencils.*
R	:	*Try to be checked again, what is appropriate analogy like that?*
S1	:	*(Smiling) Yes sir, is not (while reading the vignette) known Firza buy 5 books and 2 pencil. This means that the number of its x and y wrote his book many pencils.*

From an interview can be seen that the S1 still believes that the analogy is written in a comment in the vignette is correct. Although he was given the opportunity to re-examine the analogy made, S1 remains convinced that the analogy made appropriate. This indicates that S1 is still less careful in understanding this one case. From the excerpts of the interview can also be seen that the S1 can judge that the completion of the written student (Ghildan) is correct, it is seen from the final settlement obtained already meet SPL given. Here S1 did not provide a reason why the settlement is correct.

Vignette case 2

In case 2, S1 responded as follows:

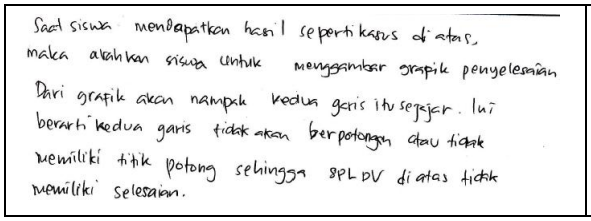
	*when students get results like the above, then the student is directed to draw graphics solution. of the graph will look two lines parallel. This means that both lines will not intersect or do not have a cut-off point, so SLETV above concluded that have no solution.*

Figure 5 Response of S1 in vignette case 2

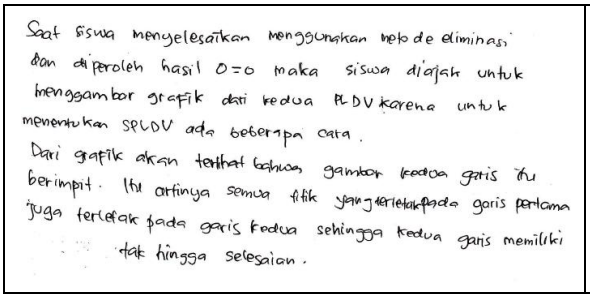
The responses indicate that S1 could provide an alternative way to explain to students how if substitution methods produce the form 0 = 1, ie with the help of graphs SPL. S1 also provides conclusions from the completion of the SPL. Nevertheless, S1 has not provided an alternative way other than using a graph. So that when the researchers tried to interview to clarify the comments above S1 through excerpts of the interview follows:

R	:	*If I may know, what is the representation of a solution of SLETV?*
S1	:	*In the form of cutting point Sir. So if the pictures, graphs of SPL in case 2 will be two parallel lines, so there is no point of intersection. Which means that the SPL does not have a solution.*
R	:	*Perhaps there are other explanations besides using graphs?*
S1	:	*No Sir.*

From an interview can be seen that the S1 only able to give an explanation of the results 0 = 1 using the graphical method.

Vignette case 3

Figure 6 Below is the response of S1 in a vignette case 3. Based on these responses can be seen that the S1 can give one alternative way to explain to students what if the elimination method generates the form of 0 = 0, ie with the help of graphs SLETV.


Saat siswa menyelesaikan menggunakan metode eliminasi dan diperoleh hasil 0=0 maka siswa diajak untuk menggambar grafik dari kedua PLDV karena untuk menentukan SPLDV ada beberapa cara.
Dari grafik akan terlihat bahwa gambar kedua garis itu berimpit. Itu artinya semua titik yang terletak pada garis pertama juga terletak pada garis kedua sehingga kedua garis memiliki tak hingga sefesaian.

When students complete the elimination method and the results 0 = 0, then the students are invited to draw a graph of the second LETV because there are several ways to determine the solve SLETV.
From the graph will be seen that both of two lines are coincides line, which means that all point located on the first line is also located on the second line so that the two lines have infinite number of solution.

Figure 6 Response of S1 in vignette case 3

As for a fuller explanation stated that if the SPL is drawn, it will get two lines are coincident. S1 also provides conclusions from the completion of the SPL. Nevertheless, S1 has not provided an alternative way other than using a graph. At the time of the interview the researchers tried to clarify comments S1, the previous discussions with researchers S1 could eventually provide an explanation other than the use of graphs, and following an interview which showed that:

R	:	*You may be able to give an other explanation for this cases 3 than the with charts?*
S1	:	*Look, we write down the equation 0x + 0y = 0, then we determine the values of x and y are hits. Here any values of x and y certainly meets Sir.*
R	:	*How many values of x and y that satisfy?*
S1	:	*Infinity Sir. Eg x = 1 and y = 2.*

From the excerpts can be seen that the S1 has been trying to provide an explanation regarding the case 3 by means other than graphics, but this explanation still needs to be clarified, because the DA to give a statement "here any values of *x* and *y* certainly meets Sir". In fact, if returned to SPLnya solution are not any values of *x* and *y*. Therefore, researchers clarified through the interview excerpts below:

R	:	*Try checking again, it is a value that satisfies 0 x + 0y = 0, but whether it meets the SPL supplied?*
S1	:	*(Counting a while) no sir.*

From the excerpts of the interview can be seen that the S1 is still not fully understood form 0 = 0 from the elimination. Supposedly when adjusted for the procedure elimination method, when two equations are eliminated, it will be wasted one variable and leave one other variable. In these excerpts, S1 finally realized his mistake after re-checking. Thus, with a brief discussion S1 can write the form 0 = 0 as 0x = 0, which means that there are infinitely many *x* that satisfies the equation, one of them for example *x* = 1. Having obtained *x* = 1, then substituted into one of the expressions of the SPL and obtained value of *y* = 14/3.
Based on the presentation of data above related to the components pedagogical content knowledge can be as discussed as follows.

Knowledge of Teaching

In the component knowledge of teaching, S1 is still putting the procedure rather than the concept but had tried to help build understanding for students. For example in cases 2 and 3, S1 is using graphics rather than interpret the deeper form 0 = 1 and 0 = 0. As related to his role as assessor and a reminder, the subject of DA has been able to assess the results of the students' work, although not consistently. Based on the description then generally it can be said that the knowledge taught S1 is at "level 1".

Knowledge of Learners

S1 showed good knowledge in facilitating students to solve problems has been demonstrated quite well. For example, to guide students in solving SLETV, if it produces a 0 = 1 or a 0 = 0 when eliminated or substituted then it is suggested to use graphic. But in diagnosing errors S1 students still need to be improved. For example, in the case of 1, S1 has not been able to demonstrate an error in the analogy of the student. Therefore in general, it can be concluded that the knowledge of the students S1 is at "level 1".

Content Knowledge

S1 is less precise in doing analogy about the story into a variable, so that in case 1 when students write analogy x = notebooks and y = and pencils subject considers the analogy is appropriate. However, S1 has been quite good at using graphic representations, namely to provide an explanation for the case 0 = 1 approach charts. So in general knowledge of the content S1 is at "level 1" as well.
Summary results of analysis of the S1 PCK shown in Table 2 below.

Table 2 Summary Analysis of PCK S1

Component of PCK	Level
Knowledge of Teaching	Level 1
Knowledge of Learners	Level 1
Content Knowledge	Level 1

Although S1 already attended training programs on teacher professionalism (PPG), turns S1 has not shown good pedagogical content knowledge. it's likely because S1 teaching experience is 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. Gatbonton found that pedagogical knowledge was similar between the two groups, but seems to have a group of experienced teachers pedagogical knowledge that is more detailed, particularly in regards attitudes and behavior of students. This study showed that college programs and the field are very helpful in developing the pedagogical knowledge of teachers, but a few years of experience will help build that knowledge to make it more specific and useful (Gatbonton, 2008).

Subject 2 (S2)

Vignette case 1

S1 elicits responses in case 1 as follows:

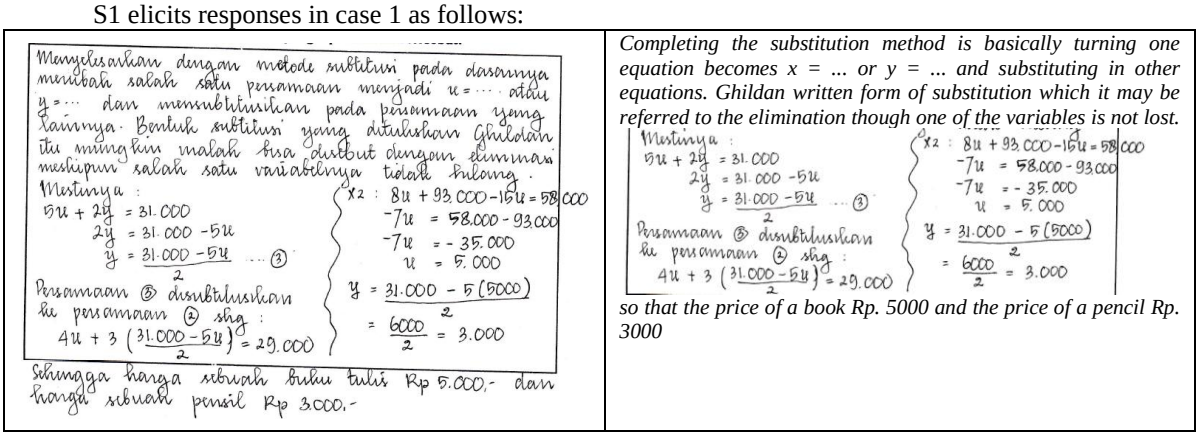


Figure 7 Response of S2 in vignette case 1

Seen that S2 directly comment on how the settlement is carried Ghildan, without commenting on the first step of analogy. In fact, in this analogy goes wrong steps are a pretty basic concept. S2 stated that the method is not written Ghildan substitution method because it is not in accordance with the procedures substitution method. According to the method used Ghildan S2 are closer to elimination method, although it cannot be said of the methods of elimination because the procedure used was also not as usual elimination method. Associated with the completion of the first step Ghildan, that analogy, the researchers tried to find out the response S2 through the interview as follows:

R	*:*	*From the story about the student named Ghildan write analogy, x = book, y = pencil. Do you think the analogy is right or not?*
S2	*:*	*Has not Sir, I think the opposite. That is, as you know: the story sounds notebooks and pencils, then the analogy are notebooks = x, and pencil = y.*
R	*:*	*In your opinion, x or y (variable) in the SPL result is what?*
S2	*:*	*Numbers Sir.*
R	*:*	*Now, if x is a number or rather the real numbers, the analogy does not match what is written Ghildan it?*
S2	*:*	*O yes, it means less suitable Sir, should x = price of the book, y = price of the pencil.*

From an interview can be seen that the S2 did not realize where the mistakes were written Ghildan analogy in the vignette. S2 begin to realize there is something wrong after receiving questions from the researcher about the value of a variable in the form of real numbers, not the states of matter such as books and pencils.

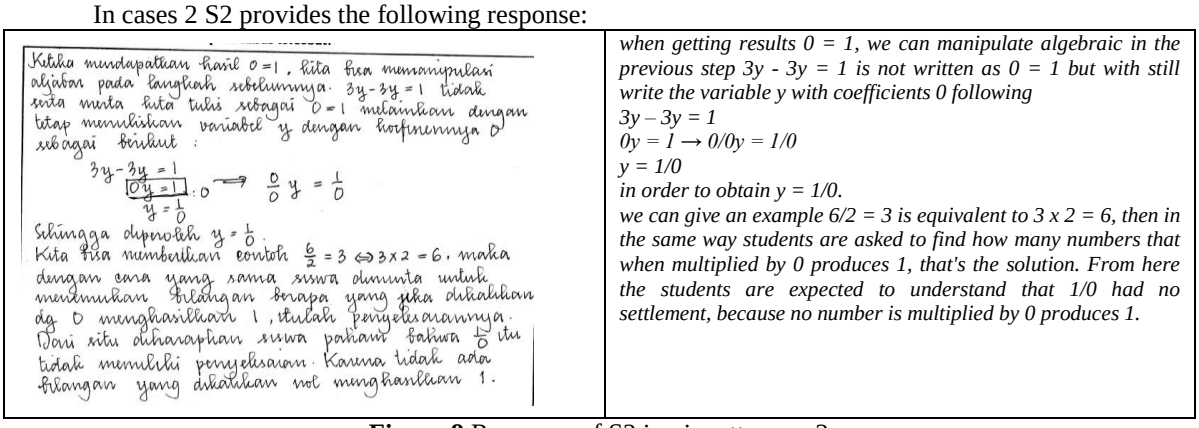
While the completion of the work associated with the process Ghildan S2 has not provided an explanation, whether the job is right or not in accordance with the existing procedures in algebra. Therefore, through interviews of researchers trying to explore the opinions or comments of S2 as the following excerpt:

S2	*:*	*In my opinion, the methods used are not clear, Sir. If elimination, why not eliminate one of the variables. If the substitution, really begins with steps like elimination. So the method is less precise.*
R	*:*	*What about the results?*
S2	*:*	*The result is correct sir. Already I check it was true. But his methods are less precise.*

According to S2, Ghildan work has actually been true, but the procedure used instead of using the method of substitution or elimination, as the first step Ghildan summing two equations and produce a new equation which variables are still two, and it is not found in elimination method. So that researchers warned that such a move slightly according to the equation elementary operations, which allow two equation variables are added or subtracted although still 2.

Vignette case 2

In cases 2 S2 provides the following response:



Ketika mendapatkan hasil 0 = 1, kita bisa memanipulasi aljabar pada langkah sebelumnya. 3y - 3y = 1 tidak serta merta kita tulis sebagai 0 = 1 melainkan dengan tetap memunculkan variabel y dengan koefisiennya 0 sebagai berikut :

3y - 3y = 1

0y = 1 : 0 → 0/0 y = 1/0

y = 1/0

Sehingga diperoleh y = 1/0.

Kita bisa memberikan contoh 6/2 = 3 ⇔ 3 x 2 = 6, maka dengan cara yang sama siswa diminta untuk menemukan bilangan berapa yang jika dikalikan dg 0 menghasilkan 1, itulah penyelesaiannya. Dari situ diharapkan siswa paham bahwa 1/0 itu tidak memiliki penyelesaian. Karena tidak ada bilangan yang dikalikan nol menghasilkan 1.

when getting results 0 = 1, we can manipulate algebraic in the previous step 3y - 3y = 1 is not written as 0 = 1 but with still write the variable y with coefficients 0 following
3y – 3y = 1
0y = 1 → 0/0y = 1/0
y = 1/0
in order to obtain y = 1/0.
we can give an example 6/2 = 3 is equivalent to 3 x 2 = 6, then in the same way students are asked to find how many numbers that when multiplied by 0 produces 1, that's the solution. From here the students are expected to understand that 1/0 had no settlement, because no number is multiplied by 0 produces 1.

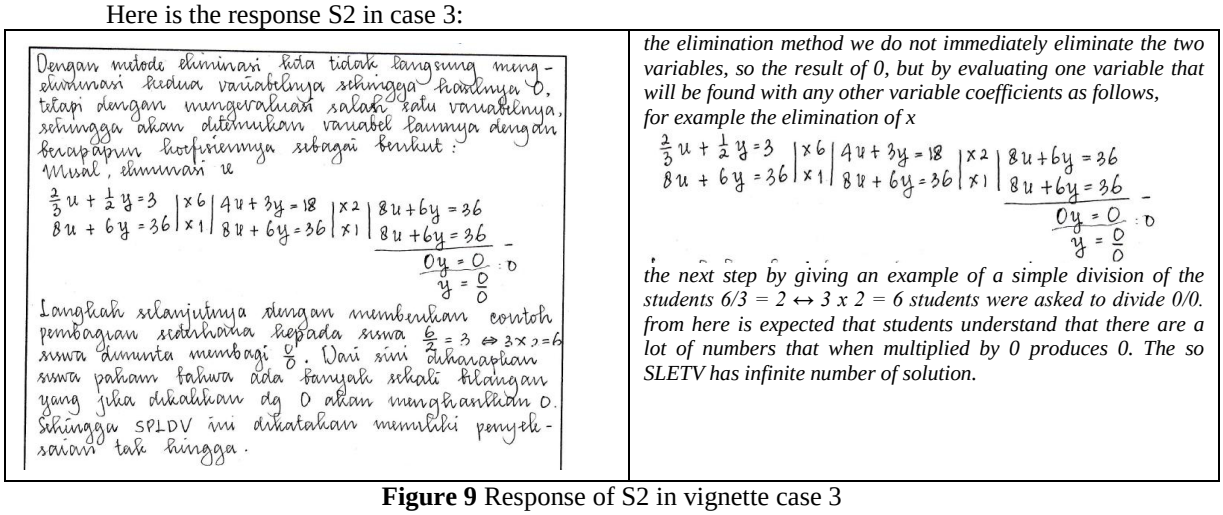
Figure 8 Response of S2 in vignette case 2

S2 has been able to provide an explanation that is readily accepted by the students, that is, when getting the substitution 0 = 1, students are confused with the results given the explanation that 0 on the left side is actually 3*y* – 3*y*. So that the substitution process could know the results, then 3*y* - 3*y* written as 0*y*, so the equation 0*y* = 1. Furthermore, students are asked to menentukam value *y* of the equation. If students are confused in explaining the results, the S2 gives an illustration using integers, eg 6/3 = 2 which is equivalent to 3 × 2 = 6. So students can conclude that the value of y in equation 0*y* = 1 is undefined. As the results of the interview as follows:

S2	*:*	*When we eliminate or substitute, the principle is to eliminate one of the variables, and leaving other variables. So if after eliminated or substituted yield 0 = 1, then we manipulate for example be 0Y = 1. So the value of y = 1/0; Well, here usually also have problems, because there are students who answered the result is 0 and no one answered the result 1.*
R	*:*	*Keep going, how do you explain it to the students?*
S2	*:*	*We make an example of the usual division Sir, for example 6/2 = ..., ... the students to fill us remind that the form 6/2 = ... is equivalent to 6 = ... × 2. So the result 3. Similarly to 1/0 = ... we change into 1 = ... × 0, so ... are not met by any number.*
R	*:*	*What does it means?*
S2	*:*	*Undefined Sir.*

Vignette case 3

Here is the response S2 in case 3:



Dengan metode eliminasi kita tidak langsung menghilangkan kedua variabelnya sehingga hasilnya 0, tetapi dengan mengevaluasi salah satu variabelnya, sehingga akan ditemukan variabel lainnya dengan berapapun koefisiennya sebagai berikut :

Misal, eliminasi x

$\frac{2}{3}x + \frac{1}{2}y = 3 \mid \times 6 \mid 4x + 3y = 18 \mid \times 2 \mid 8x + 6y = 36$

$8x + 6y = 36 \mid \times 1 \mid 8x + 6y = 36 \mid \times 1 \mid 8x + 6y = 36$

$0y = 0$

$y = \frac{0}{0}$

Langkah selanjutnya dengan memberikan contoh pembagian sederhana kepada siswa $\frac{6}{2} = 3 \Leftrightarrow 3 \times 2 = 6$ siswa diminta membagi $\frac{0}{0}$. Dari sini diharapkan siswa paham bahwa ada banyak sekali bilangan yang jika dikalikan dg 0 akan menghasilkan 0. Sehingga SPLDV ini dikatakan memiliki penyelesaian tak hingga.

the elimination method we do not immediately eliminate the two variables, so the result of 0, but by evaluating one variable that will be found with any other variable coefficients as follows,
for example the elimination of x

$\frac{2}{3}x + \frac{1}{2}y = 3 \mid \times 6 \mid 4x + 3y = 18 \mid \times 2 \mid 8x + 6y = 36$

$8x + 6y = 36 \mid \times 1 \mid 8x + 6y = 36 \mid \times 1 \mid 8x + 6y = 36$

$0y = 0$

$y = \frac{0}{0}$

the next step by giving an example of a simple division of the students 6/3 = 2 ↔ 3 x 2 = 6 students were asked to divide 0/0. from here is expected that students understand that there are a lot of numbers that when multiplied by 0 produces 0. The so SLETV has infinite number of solution.

Figure 9 Response of S2 in vignette case 3

The explanation given by S2 in the case 3 is similar to the case 2. S2 concluded that the SPL in this case has not up to much solution, but there is no explanation of how the settlement in question. It also can be

seen S2write the equation $0y = 0$ is equivalent to $y = 0/0$. According S1 it can be obtained by dividing both sides by 0. Therefore, researchers try to explore further knowledge of the subject S2 as excerpts of the interview follows:

S2	*:*	*In my opinion are equivalent Sir, because as I wrote it $0y = 0$ if both sides devided by 0, will obtain $y = 0/0$.*
R	*:*	*Is $0/0 = 1$?*
S2	*:*	*(Seem to think) O yes Sir, 0/0 that value can be 1, can be 2, and so forth, means not equivalent.*

From the excerpts shown that S2 regard both sides divide by zero is undefined allowed and 0/0. But when asked how much the value of 0/0, S2 responded that its worth a lot. S2 also commented that in addition to using an analytical approach as above, to give a description of the SPL cases 2 and 3 can use the chart, that if the graph SPL are intersected, the SPL has exactly one solution, if overlaps have infinitely many solutions, and if parallel does not have a solution.

Based on the presentation of data above related to the components pedagogical content knowledge can be as discussed as follows.

Knowledge of teaching

S2 had tried to help students construct meaning and understanding. For example in the case of 2 and 3 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 $0y = 0$. From the form of the expected students can find relevant conclusions SLETV settlement. Besides S2 also has another alternative explanation is to use charts. While related to his role as assessor and a reminder, S2 have been able to assess the results of student work properly. Based on the description then generally it can be said that the knowledge of teaching of S2 is at "level 2".

Knowledge of learners

S2 less able to diagnose the students' mistakes. This is shown by not showing errors analogy of the student in case 1. But in facilitating the students to solve problems, S2 demonstrated well, for example to guide students in solving SLETV, if it produces a $0 = 1$ or a $0 = 0$ at the time eliminated or substituted then students are asked to write down the results, for example as $0y = 1$ and $0y = 0$. So in general it can be concluded that knowledge of learners of S2 is at "level 2".

Content knowledge

S2 assume analogy x = notebook and y = a a pencil in case one is not quite right, but the subject let the student make the analogy because it is not a meaningful error. S2 also considers $0y = 1$ is equivalent to $y = 1/0$ and $0y = 0$ is equivalent to $y = 0/0$. But in the delivery of explanation, S1 is able to demonstrate knowledge of conceptual and procedural pretty good. So in general knowledge of the subject content is still at the "level 1".

In summary the general conclusion of the analysis PCK S2 are presented in Table 3 below.

Table 3 Summary Analysis of PCK S2

Component of PCK	Level
Knowledge of Teaching	Level 2
Knowledge of Learners	Level 2
Content Knowledge	Level 1

Although S2 has only 3 years of teaching experience, but because the neighborhood / school where the teacher is teaching is one of the featured schools, it turns S1 able to demonstrate good pedagogical content knowledge. This is due to the environment (context) as it is, S1 must adapt so much to learn and actively pursue proseionalisme teacher training. Knowledge of context was mentioned by many researchers as an essential component of pedagogical content knowledge (Abd Rahman & Scaife, 2005; Grossman, 1990; Marks, 1990; Veal & MaKinster, 1999). Because of that, awareness of knowledge of context was investigated through the study.

IV. Conclusion

A general description pedagogical content knowledge of the subject 1 is the knowledge of teaching, the knowledge of learners, and the content knowledge they are all on level 1. As for the subject 2, the knowledge of teaching and the knowledge of learners are at level 2 and content knowledge is at level 1. Factors affecting pedagogical content knowledge of the teacher include teaching experience, educational background, professional training have been followed, and the environment in which teachers teach.

References

[1] B. Karahasan, *Preservice Secondary Mathematics Teachers"Pedagogical Content Knowledge Of Composite And Inverse Functions*. doctoral diss.,Secondary Science and Mathematics Education Department, Middle East Technical University, 2010, Turki.

[2] E. Gatbonton, Looking beyond teachers' classroom behaviour: Novice and experience ESL teachers' pedagogical knowledge. *Language Teaching Research*, 12(2), 161-182. 2008, doi: 10.1177/1362168807086286

[3] F. Abd Rahman, & J.A. Scaife, Assessing pre service teachers" pedagogical content knowledge using a bricolage approach. *The Twelfth Learning Conference on Learning- in the Faculty of Education at the University of Granada*, July 2005.

[4] J. Gess-Newsome & J. Carlson, Pedagogical content knowledge summit: A new way to visit an old construct In M. Giamellaro (Chair), Pedagogical content knowledge: Considering models, methods, and recommendations from the PCK summit. *Symposium conducted at the meeting of the American Education Research Association, Philadelphia, PA, 2014*, (Online http://bscs.org/sites/default/files/_media/community/downloads/AERA.PCK.Summit.April2014.pdf accessed on 20th June 2016).

[5] J. Loughran, A. Berry, & P. Mulhall, *Understanding and developing science teachers' pedagogical content knowledge*, Rotterdam, The Netherlands: Sense Publishers, 2006.

[6] J.T. Abbitt, Measuring Technological Pedagogical Content Knowledge in Preservice Teacher Education: A Review of Current Methods and Instruments. *Journal of Research on Technology in Education*. 43(4), 2011, 281-300.

[7] L.S. Shulman, Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2), 4-14, 1986, doi:10.2307/1175860

[8] M. Rollnick, J. Bennett, N.D. Rhemtula, & T. Ndlovu, The place of subject matter knowledge in pedagogical content knowledge: Acase study of South African teachers teaching the amount of substance and chemical equilibrium. *International Journal of Science Education*, 30 (10), 2008, 1365-1387.

[9] P.L. Grossman, *The making of a teacher: Teacher knowledge and teacher education*. New York: Teachers College Press, 1990.

[10] P.W. Thompson, Images of rate and operational understanding of the fundamental theorem of calculus, *Educational Studies in Mathematics*, 26, 1994, 229-274.

[11] R. Marks, Pedagogical content knowledge: From a mathematical case to a modified conception. *Journal of Teacher Education*, 41(3), 1990, 3-11.

[12] S. Lindgren, Thompson's levels and views about mathematics. An analysis of Finish preservice teachers' beliefs, *Zentralblatt für Didaktik der Mathematik*, 28, 1996, 113–117.

[13] Subanji, Peningkatan Kinerja Guru Indonesia: Sebuah Refleksi 5 Tahun Perjalanan TEQIP, *Jurnal TEQIP Tahun VI*, Nomor 2, November 2015.

[14] W. Veal, & J. MaKinster, Pedagogical content knowledge taxonomies. *Electronic Journal of Science Education*, 3(4), 1999, 47-56.