From Pedagogical Knowledge to Pedagogical Content Knowledge: Development in Mentor and Student-Teacher Group Conversations

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Abstract. This case study focuses on mentor group conversation meetings with primary student-teachers, demonstrating how student-teachers´ reflections on classroom experiences might influence their understanding of the complicated relationship between teaching, subject matter content and the context. The aim is to study how mentors´ and student-teachers´ reflections affect (or not) the student-teachers´ development of pedagogical content knowledge (PCK). The theoretical framework derives from a sociocultural perspective, emphasising the collective character of teaching and learning. The empirical material consists of video documented mentor group conversations during one semester within an academic school context. Findings show development of PCK, highlighting a transition from pedagogical knowledge and contextual knowledge, to a blending of subject matter knowledge, pedagogical knowledge and contextual knowledge. This blending only occurred when the student teachers reflected on their teaching. Findings demonstrate the need to systematically explore student-teacher reflections of their teaching in practice to discern how different knowledge bases integrate into PCK.

Keywords: teacher education; pedagogic content knowledge; student-teachers; mentors.

Introduction

An important aspect of teacher education concerns how to prepare student teachers for their future careers as teachers in a favourable way. Therefore, research is needed into how different elements of teacher knowledge are develop during teacher education programs. A common approach to ensure student teachers´ professional learning is to engage them in self-reflection of their teaching performance to capture and portray complexity of teaching and learning (Loughran, Berry & Mulhall, 2012; Nilsson, 2014; Nilsson & Karlsson, 2019; Van Driel & Berry, 2012). A significant emerging issue is that teacher education does not always manage to provide support for student-teachers to

integrate different knowledge bases (Nilsson & Loughran, 2012). Consequently, teacher education should provide student-teachers with both content knowledge and pedagogical skills to better prepare them for the complexity of teaching.

Several researchers indicate the significance for teacher educators to provide opportunities for student-teachers to reflect on, observe and analyse their own and other´s teaching (Hordvik, MacPhail, & Rongland, 2009; Livy, Downton & Muir, 2017; Nilsson & Karlsson, 2019). Therefore, this study addresses how these reflections might help student-teachers´ growing understanding of the relationship between teaching, content and context in order to facilitate a development of PCK (pedagogical content knowledge). Since Shulman (1987) introduced the concept of PCK, several scholars in educational research have attempted to use it as a framework for describing and analysing teacher knowledge. According to Chan and Hume (2019), PCK represents the special professional knowledge and the different skills a teacher needs to teach well and to promote learning. PCK consists of several different components and can be viewed both as individual and collective.

The aim of this particular study is to investigate how mentors´ and student-teachers´ reflections affect (or not) the student teachers´ development of pedagogical content knowledge (PCK). The research question of the study is: In which way do (or do not) conversations between mentor and student- teachers develop student-teachers´ PCK?

Literature review

In teacher education, several studies concern reflective practice and the significance of linking theory to practice, to capture and develop student-teachers´ professional knowledge. The development of PCK among student teachers during practicum has been a focus of Hong (2015), indicating that after the practicum period, the student-teachers were more aware of the significance of teaching strategies for their teaching. They also acknowledged assessment as a way of evaluating both their teaching and their students´ learning (Hong, 2015). In Sport education, a three-level model of learning was applied to focus on student teachers´ development of knowledge and teaching (Hordvik, et al. 2009). As the student teachers developed both awareness and understanding about teaching and learning, Hordvik, et al. (2009) conclude that teacher educators should enable their student-teachers´ continuing practical and theoretical knowledge and teaching development.

Concerning PCK, Nilsson & Loughran (2012), investigated the development of PCK among a group of science student-teachers. By using a CoRe (content representation) as a tool for reflection when planning and assessing their teaching, the student-teachers focused on components important for developing their PCK. (Nilsson & Loughran, 2012). Further, a CoRe, combined with a video annotation tool were used to develop student-teachers´ PCK. These tools were shown to both scaffold and structure student-teachers´ reflections on actions related to components of PCK (Nilsson & Karlsson, 2019). Another study

(Rosenkränzer, Hörsch, Schuler & Riess, 2017), investigated three interventions´ effects compared to student-teachers´ PCK for teaching systems thinking in science teacher education. Findings reveal that mixed courses and courses focusing on learning and teaching appear to be more effective in developing student-teachers´ PCK, than technical courses lacking didactical aspects. In a study concerning Mathematics pedagogical content knowledge (MPCK), the importance of methodology courses in teacher education has been emphasised (Lim-Theo, Chua, Cheang & Yeo, 2007). The student-teachers show development of their MPCK, after having completed their mathematics pedagogy course. When focusing on developing student-teachers´ teaching knowledge, it is demonstrated that authentic work samples facilitate their ability to relate to their students´ mathematical understanding. It also made their knowledge base explicit related to their students´ development (Livy, et al. 2017).

A lesson series was developed to evolve student-teachers´ content knowledge in rational numbers and pedagogical content knowledge (Depaepe, et al. 2018). In the intervention group, unlike in the comparison group, the teaching was co-developed by researchers and focused on students´ misconceptions, as well as on strategies to overcome the same. Also, video sequences functioned as a teaching tool. The intervention group reached a higher development in contextual knowledge (CK) and PCK than the comparison group, indicating that these lessons were useful in developing the student-teachers´ learning. When studying self-reflection among student-teachers in Chemistry, the student-teachers´ task was to identify critical episodes in the subject matter content, alongside with student difficulties and teaching methods (Ibrahim, Surif, Arshad, & Mokhtar, 2012). The student-teachers showed a gradual development from only reflecting a few issues related to general and descriptive aspects to more critical and elaborated reflections on issue-based pedagogical content knowledge, due to prior guidance from teachers.

Pedagogical Content Knowledge

In (1987), Shulman introduced the concept pedagogical content knowledge (PCK). As such, he highlighted the significance of the unique blend of content knowledge and knowledge of general pedagogy. Originally, PCK was developed to represent one of the professional knowledge bases of teachers. In Shulman´s work (1987), PCK was described as a representation of a blending of content and pedagogy that makes possible an understanding of how a particular topic is organised, represented and adjusted to different abilities of learners. Thus, PCK concerns the complex relationship between content and teaching, a process that is incorporated into classroom practice (Loughran et al. 2012).

During the last decades, researchers have developed conceptualisations of PCK (e.g. Gess-Newsome, 2015; Nilsson & Loughran, 2012; Nilsson, 2014; Park, Jang, Chen, & Jung, 2011; Rollnick, Bennett, Rhemtula, Dharsey, & Ndlovu, 2008), as an academic construct that represents expert knowledge of the practice. In the PCK Summit Consensus Model, Gess-Newsome (2015) illustrated how teacher knowledge for teaching is connected to the actual classroom teaching and the student´s learning. The model concerns what the teacher knows and how it

comes into the classroom with considerable impact on the students' understandings. In a second PCK summit meeting in 2016, the PCK Summit Consensus Model was reworked and upgraded to the 2017 Refined consensus model of PCK, (RCM) (Carlson & Daehler, 2019). RCM has a stronger focus on student learning in relation to PCK, highlighting the practice of teaching.

Sixteen years before the PCK Summit Consensus Model, Gess-Newsome (1999) created an epistemological way to describe a different model of teacher knowledge. On one hand, in the Integrative model, PCK does not exist since teacher knowledge only consists of the intersection of context, subject matter and pedagogy. Classroom teaching becomes an activity of integrating knowledge across these three different areas to create effective learning opportunities. An important issue of the Integrative Model is that it separates domains of knowledge that can be developed independently and integrated at a later stage. However, a risk is that teachers may never realise why such integration is important. On the other hand, the Transformative model represents a synthesis of knowledge that teachers need to be effective. Here, PCK is described as the form of knowledge that influences the teaching practice, the transformation of a teacher´s contextual knowledge (CK), pedagogical knowledge (PK) and subject matter knowledge (SMK). Hence, a skilled teacher has transformed PCK for his/her subjects. Yet, the model might risk to objectifying teaching and neglecting teachers´ creativity and personal growth.

Since Gess-Newsome (1999) presented her model, several models for analysing PCK have been introduced, such as a model with five components (Magnusson, Krajcik, & Borko, 1999), and a model for Topic-Specific PCK (Rollnick et al. 2008). In the context of the present study, we have returned to the initial model by Gess-Newsome (1999) and view PCK development as a process where contextual knowledge (CK), pedagogical knowledge (PK), and subject matter knowledge (SMK) develop together. The primary reason is that it corresponds with how the student-teachers and mentors are reflecting during group conversations in the data material.

Theory, methodology and analytical tools

Teacher educators should provide student-teachers with access to resources that function as tools for creating meaningful social interaction in teaching practices. From this perspective, this study originates from sociocultural perspectives, that stress the collective character of teaching and learning (Vygotsky, 1978). Levykh (2008) accentuates Vygotsky´s emphasise on both affect and intellect related to learning and development, as closely linked to each other and interdependent. Such a social origin of the learners´ learning and development is represented by the zone of proximal development (ZPD). This concept reflects the distance between independent problem-solving and the potential growth in problem-solving with assistance of/collaboration of more capable peers, where the collective achieve more than the individual (Vygotsky, 1978; Levykh, 2008; Wertch, 1984). Thus, ZPD is defined as a mutual learning process where the participants learn by interacting with each other (Tudge & Scrimsher, 2003). The ZPD is a way of describing Vygotsky´s notion of how learning can lead to

development. The learning activities are mainly designed by educators providing a framework for guided instructions (Levykh, 2008). Hence, the character and dynamics of collaboration within the group guide the individuals.

As the study focuses on two mentors and their student-teachers, we used a qualitative case study methodology. By using such an approach, one study the case within the participants´ real-life professional context (Yin, 2009). In the study, we conducted a qualitative analysis, based on content analysis (Graneheim & Lundman, 2004). The analysis was based on the patterns derived from data during mentor group conversation meetings with primary student-teachers, and was divided into inductive and deductive phases, as described in Table 1:

Table 1: Analysis phases and focus

Analysis phase	Focus of analysis
Inductive 1	The video material was watched several times, and an initial analysis contributed with an overarching understanding of the content.
2	The two authors, independently, developed themes out of students-teachers´ reflections.
Deductive 3	The video reflections were analysed, and in terms of specific examples of student-teachers´ reflections, related to pedagogical knowledge (PK), context knowledge (CK) and subject matter knowledge (SMK), (Gess-Newsome, 1999).
4	Final themes were discussed between researchers until consensus was reached.
5	All data were re-read by both authors independently in order to verify the patterns.
6	Selection of data that represents expressions/reflections of the participants´ development of PCK was selected to be presented in the paper.

PCK and components herein (PK, CK, SMK) constitute analytical tools in the study. Data coded as mainly PK expressed how the teacher or student-teacher interacted with their students when teaching. It also included reflections of teaching activities, for instance classroom communication, instructional strategies and questioning techniques. Data coded as mainly CK concerned reflections of the context in which the teaching took place, and student behaviour. For instance, this concerned how students cooperate within the classroom, knowledge of learning strategies, student abilities and their prior knowledge of, and attitudes towards the topic. Data coded as mainly SMK included student-teachers´ conceptual understanding of a topic. For instance, this included an understanding of the nature and structure of the topic. Inter-coder reliability, to justify the validity of the coding, was tested by both authors related to the application of PK, CK and SMK to the data material. Only when reflections were coded in the same way by both authors, they were accepted as valid data for analysis. The transcribed video sequences in the findings section are therefore indicative based on the tendency of given knowledge bases (PK, CK or SMK) to be the main part of the data. In line with Geertz, (1974), the sessions were analysed to produce thick descriptions of student-teachers´

reflections. Transcripts are selected to illustrate the range of responses and reactions to involvement in the mentoring process and the school-based practice.

Design

This study is situated within an 'academic school context', in which the primary ambition is to increase the quality of practicum, through specific forms of student-teacher-mentor conversations as well as student-teacher-student-teacher collaborations. At the university level, this model for academic schools implies a new organisation of practical placement where all mentors have a particular mentoring training and where so-called 'activity integrated days' (AI-days) are compulsory for student-teachers in addition to regular practicum periods. During AI-days, student-teachers are involved in teaching and school activities but not necessarily assessed by their mentor. As a part of the academic school organisation, the student-teachers and their mentors meet regularly in the form of mentor-student-teacher group conversations. To make teacher-student conversations more rooted specifically in classroom practise, sequences of video documented teaching were used to initiate close practice reflections. Studies involving video-documented data have their potential limitations. For instance, the presence of the camera could have impact on the participants´ way of reflecting, making them change their comments to appear in a more favourable way. However, in line with Heath, Hindmarsh, & Luff, (2010) this did not appear to be as a significant problem, as the participants did not seem to notice the video camera.

The context for research took place in two primary schools, (students 6-11 years old.) School A was situated near a larger town whereas school B was located in a rural setting. At each school, there were three to four mentors and three to six primary student-teachers within the academic school context. The students have had teaching experiences during their teacher education before the study. One of the mentors at each school arranged group conversation meetings with all student-teachers, during the AI-days. The mentors had previous experience in teaching and mentoring and were free to choose mentoring strategies during the sessions. The research was conducted during the fourth semester of a four-year teacher education program. At the beginning of the study, mentors and student-teachers were asked to take part in the study, and all agreed. Their participation was voluntary and the project was not a part of a course assessment. They were also informed orally and in writing about the study´s purpose, schedule, how the materials would be stored, presented and published, and who to contact with any questions about the research project. In the text, they have been given pseudonyms.

This paper focuses on student-teachers ´ development of PCK, emanating from 12 h of video-documented mentor-student-teacher group discussions, completed by two mentors and four student-teacher groups (see Table 2), during one semester. In the academic school context, groups of student-teachers discussed video documented teaching with their mentor during AI-days at their academic schools. Each discussion lasted approximately one hour and usually comprised reflections related to three video sequences. Two student- teacher groups had

conversations with mentor one at school A and two student-teacher groups had conversations with mentor two at school B. The groups varied from three to six student-teachers. Altogether, eighteen student-teachers and two mentors (female) participated in the study.

Table 2: An overview of student-teacher groups and mentors.

Mentor	Student-teacher groups
Mentor one	five student-teachers
Mentor one	six student-teachers
Mentor two	three student-teachers
Mentor two	four student-teachers

Results

The result section that follows presents an analysis of the development of PCK in student-teacher-mentor reflections, highlighting a transition from pedagogical knowledge (PK) and contextual knowledge (CK) in Theme 1, to a blending of subject matter knowledge (SMK), PK and CK in Theme 2.

Theme 1: Student-Teachers Focusing on PK and CK in Teaching

At the beginning of the semester, the task for the student-teachers when preparing, was to video document a teacher´s teaching, select a sequence and formulate a question to discuss during the group conversation. During this period, the student-teachers primarily focused on pedagogical and contextual knowledge in their reflections.

The Teacher Presents for the Class

On the video sequence, teacher Fiona presents the concept of 'time' for the children. She sits on the floor with the children and speaks in a low voice to one group at a time. During the seminar, after having watched the video, student-teacher Anne that selected the sequence summarizes her focus and asks a question:

Anne: The teacher believes that they will think on their own, but some groups do not seem to start a discussion and then she approaches them and forces them to speak. But as soon as she leaves, we saw that they stopped talking, and so does the other group. So, my question is, how are you supposed to act in a situation like this? Should she be satisfied when they have mentioned one aspect of the concept of time, or should she ask more questions?

Linda: I think they will talk more if they are in smaller groups.

Beatrice: I think it is quite common that they talk about other things.

Anne: No, they did not say anything.

Mentor 1: That is a matter of focus. How can you, as a teacher, know that they continue talking or not? Is the talking itself the focus of the lesson, or is it to teach the students about the concept of time?

As a student-teacher, Anne focuses on the way the teacher chose her instructional strategies and how they affect classroom communication, and starts to express her beginning pedagogical knowledge (PK). Then, when Linda reflects on the context in which the teaching appears, she stresses the significance of the group size that affects the relationship between individuals and the behaviour of students, an expression of CK. Beatrice continues by referring how the students cooperated in the classroom (CK) and how they tend to discuss other areas than the one the teacher in the video sequence intended. This also indicates knowledge of students´ different abilities to learn and to communicate (CK). Finally, the mentor asks a challenging question that refers to the aim of the lesson. By asking whether it is the talking itself or not that is the aim of the lesson, she tries to capture a more extensive focus than on only CK and PK (i.e. the concept of time), and as such the subject matter knowledge (SMK). However, the student teachers did not take up the challenge from the mentor but continued their focus on PK and PC.

The Student-Teacher Presents for the Class

In the middle of the semester, the student-teachers were asked to video-document each other´s teaching, to select and to bring short video sequences to the group conversations. The student-teacher that was video-documented decided a focus before the lesson and prepared a question to discuss during the group conversation. Consequently, the student-teacher´ attention changed from the teachers´ teaching to their own teaching. Still, the focus in their reflections was on PK and CK, and the actual SMK was yet not visible.

In the video sequence of a history lesson, student-teacher Peter teaches the students about the development of written language in a powerpoint presentation. After having watched the sequence with the reflection group, he asks a question:

Peter: Which significance does it have for the students´ attention if I stand up or sit down?

Paula: It depends on what you are doing. When Lizette (teacher) has a lesson, sometimes she sits down while teaching and still she has the students´ attention. If you would have been seated longer, I still think you would have had their attention.

Jonas: It is harder as a teacher to see if everyone is paying attention if you sit down. You do not manage to have eye contact with them.

Mentor 1: What can you gain in terms of learning through different ways of placing the furniture in the classroom? Are there any benefits with having or not having eye contact with your classmates as a student?

Peter: During my presentation, everyone should be sitting straight ahead, but when they work, they can sit in groups. How you place the furniture depends on what you are doing.

Mentor 1: Right, it depends on the aim of the lesson. When you enter a classroom, you can almost see the teacher´s perspective on learning by looking at the way the students are placed.

Peter starts with asking a question concerning the relation between his physical expression and the students´ engagement. Thus, the question relates to how to maintain students´ attention. This indicates a focus on PK, concerning instructional strategies and instructional models in teaching, as well as on student behaviour (CK). Then, Paula addresses the method, saying that whether you should stand up or sit down depends on what you are doing and what the students are supposed to learn. Instructional strategies in the form of physical expression or body positioning are still in focus, as well as teaching procedures and strategies, indicating a focus on PK. Her comment also shows a focus on CK, when she reasons that Peter would have maintained the students´ attention even if being remained seated. This relates to her knowledge of student abilities and the behaviour of students. Next, when Jonas critically reflects upon the possibility to have eye contact with the students while sitting down during teaching, the focus on teaching strategies (PK) is maintained. Here, to present while sitting down is questioned related to classroom communication (PK). Then, although the mentor asks about the relationship between student learning and how the students are placed, Peter answers without addressing student learning. Finally, the mentor refers to the aim of the lesson from a perspective on learning by addressing the student´s learning abilities (CK) related to how the students are placed. Hence, the mentor refers to the lesson content (SMK) and classroom management (PK), while the students interested in physical expressions still are focusing PK and CK.

Theme 2: Student-Teachers Focusing on SMK, PK and CK in Teaching, Indicating an Initial Transformation into PCK

At the end of the semester, when reflecting on their video sequences, the student-teachers´ focus during the seminars changed from PK and CK to a blending of SMK, PK and CK. The teaching content in question is reflected concerning suitable methods to create right conditions for students´ learning.

The Student-Teacher Discussing Problem-Solving in Mathematics with the Class

In the video sequence, student-teacher Amy discusses problem-solving in mathematics with the class. During the seminar, they watch the sequence, and this time the mentor starts by asking a question:

Mentor 2: What do you think Amy would like to teach the students?

Lesley: I´m thinking the relation between addition and subtraction, to find the hidden number.

Clara: I agree, it isn´t just something added with something but to use reverse thinking. I mean how you initiate the discussion to discuss your way of finding the solution, not just delivering the correct answer.

Mentor 2: Other than that, what could be in focus?

Clara: I know that they have been working with the equal sign.

Mentor: That is what I was thinking, as well.

Clara: That it should be the equal amount on either side of the sign.

Mentor 2: Actually, there is another aspect that they practice, and that is super cool.

Amy: Equations.

Mentor 2: Yes, this is the foundation of equations and algebra. You (addressing Lesley) talked about that you try different solutions to solve a problem. Are they comfortable with that?

Lesley: No, they only wish to know the correct solution. They do not want to try different solutions.

The mentor starts the discussion by asking a question that concerns the students´ learning in the classroom (CK) in combination with the subject matter content in focus (SMK). In doing so, she asks for conceptualisations and underlying construct in the field of problem-solving in mathematics (SMK). The explicit combination of children´s learning and the teaching content in the questions might be suggestive of an orientation towards PCK. When Lesley suggests that Amy, teaching on the video sequence, wants the students to learn the relationship between addition and subtraction as well as the hidden number, she continues to focus on SMK. Then, the mentor asks for other possible foci, and Clara´s suggestion that the equal sign could be in centre, which she also defines, shows her knowledge of related content and how to connect one concept to another, another aspect of SMK. When the mentor asks Amy about a broader concept for the task at hand, Amy´s answer (equations) indicates that she is aware of underlying structures in mathematics (SMK). Then, when the mentor asks if it is difficult to make the students discuss in problem-solving, Amy confirms and relates to the size of the class (CK). Using discussions in her teaching indicates that she wishes to enhance the students´ learning in a way that highlights not only her PK but also a combination of CK and SMK, suggesting a growing PCK. Altogether, the border between SMK and PCK seems to be crucial in the process of transforming the subject matter content for teaching. This is indicating a transformation between understanding the subject matter and the development of PCK.

The Student-Teachers Initiates a Practical Problem-Solving in Mathematics

In the video sequence, the class works on weight units in the schoolyard during a lesson in problem-solving in mathematics. The task for the student in the video

sequence is to position himself in different squares according to the weight unit he has been assigned to on a card. Thus, the design of the teaching model implies a blending of PK and SMK, what material to include and the teaching content. This is indicative of an initial transformation towards PCK. The student-teachers comment on the video:

Deborah: So, the video sequence concerns two students who stand together and discuss their cards while we listen. Here we saw learning, that is, the boy in the sequence, he did not know what gram and hectogram meant, but he was together with this girl that understood the meaning of these concepts. Yet, she explained and did not say; 'My path is the best. You will go this way, and I will go that way' Instead she explained' … Because kilo is the heaviest and then hectogram…' and so on. Beatrice: We thought that the learning became explicit and that they were allowed to cooperate. We very much emphasised that they were to discuss with each other, and we explained why. Thus, learning can occur even though some of the students did not know that much. After having done this a couple of times, you will gain an understanding.

Mentor 2: The rest of the group, where do you see the learning in this video sequence? Are there different levels? Are there any risks? Do you miss anything?

Paul: First, I thought of if she had not told the students that kilogram comes first and then hectogram and then gram. But you said after the video sequence that you emphasised this and that they had to discuss why it appears in that way to be able to move on. But it could be that the students very much like to skip some steps, or they could have a hard time concentrating as they are in the schoolyard, where a lot is going on around them.

Here, instead of telling the correct answer as a teacher, the students are involved in collaborative problem-solving in the video sequence. The way the student-teacher used various teaching methods and ways of explaining a phenomenon to direct the students towards a better content understanding, might be suggestive of an initial transformation into PCK. Beatrice´s statement, that this method eventually will lead to student understanding, indicates a blending of knowledge of teaching content (SMK) and teaching strategy (PK) as well as knowledge about students´ learning abilities (CK). Although focusing particular concepts, she was also choosing a specific teaching model (PK) in line with the level of students´ understanding (CK) and the strong need to adapt the material to the students´ level (i.e. indicating of a growing PCK). Then, when the mentor challenges the student-teachers by asking them to critically reflect upon conditions for learning, Paul both relates to the teaching content by referring to the concepts (SMK), the teaching model and how they performed the task (PK) in combination with his knowledge of students´ abilities (CK). Altogether, both student-teachers and mentor focus on student learning, teaching methods, and teaching content in combination. This indicates a blending of PK, CK and SMK towards PCK.

Discussion

In the following, arguments will concern broader contexts than the findings. Although such generalisations might be seen as ambiguous, they are addressed to reflect and debate issues of PCK in teacher education.

The major finding in this study is that group conversations between mentor and student-teachers emanating from video sequences of teaching contribute to student-teachers´ development of PCK. Further, the results show that a combination of CK, PK and SMK only occurred when the student-teachers reflected on their teaching, not when reflecting on another teacher´s teaching. This indicates that a development of PCK could be enhanced by student-teachers analysing their teaching. In his initial definitions of teacher knowledge, Shulman (1987) placed particular emphasis on PCK as the mixture of pedagogy and content. The development of PCK in this study is characterised by a change in focus from pedagogical knowledge (PK) and contextual knowledge (CK), to an integration of subject matter knowledge (SMK), PK and CK.

The findings in this study suggest the learning from teaching, instead of the learning of teaching (Nilsson & Loughran, 2012; Nilsson & Karlsson, 2019; Hong, 2015; Livy, et al. 2017) to be a useful way to enhance student-teachers´ possibilities to integrate the subject content and the development of professional knowledge. The student-teachers´ ability to make such integration after time is manifested through their blending of PK, CK and SMK, closely related to their teaching in the classroom. However, reflections were concerning two knowledge bases at the beginning of the semester (PK & CK) while reflections indicating a transformation of three knowledge bases (PC, CK & SMK) occurred at the end of the semester. As such, the findings highlight a teacher education aimed to develop student-teachers´ collaborative and reflective skills and the importance of reflected classroom teaching in the development of their PCK.

How the three different knowledge bases PK, CK and SMK were intertwined in the students´ reflections indicate a transformative character of PCK (Gess-Newsome, 1999). During the semester, PK, CK and SMK were blended and combined in the student-teachers´ reflections. They did not appear as separate domains of knowledge that develops independently as in the Integrative model. Instead, the development of PCK was characterised by a synthesis of knowledge, following the Transformative model. As the different components interacted in a complex way, we argue that although it is essential to know the particular components (integrative model), the crucial aspect is how they interact and how this influence both reflections on teaching and the actual teaching (transformative model).

This study´s academic school context within teacher education, has the ambition to increase the quality of practicum for students. The results might be suggestive of expressions of reflections at the end of the semester that could give way to such an increased quality. The student-teachers´ way of blending PK, CK and SMK imply an initial awareness of PCK that could gain their continuing practicum during teacher education.

Further, in the academic school context, the mentor was essential in stimulating the student-teachers´ reflections on action (through the video-recorded classroom situations). The mentor´s position seemed to be of significance for the student-teachers´ way of capturing those incidents that were critical in their practice, encouraging them to widen their perspectives. Following a sociocultural perspective, the character and dynamics of collaboration within the group were reflected by the individuals, where the learning activities, designed by educators provided a framework for guided instructions (Levykh, 2008). In terms of ZPD, the more knowledgeable others assisted the student-teachers developing by continuing a focus on a combination of CK, PK and SMK, enabling the student-teachers to be in their ZPD. Hence, the results indicate that the mentor stimulated student-teachers to reflect on their teaching and to develop their teaching over time, in combination with selected video sequences. Also, the mentor had a crucial role in promoting an atmosphere of equal trust among the participants in the conversation group. This is significant, according to Vygotsky that emphasises on both affect and intellect related to learning and development, as closely linked to each other and interdependent (Levykh, 2008). As mutual trust developed over time, this might illustrate that it is more 'convenient' to discuss PK and CK, the *how* of teaching, while a focus on the *what* of teaching, the teaching content (SMK) related to student learning seems to be more delicate.

Conclusion

To conclude, as indicated in this study, student teachers´ teaching is a crucial part of the teacher education program. Further, in order to identify and capture instances of practice that make difference for student teachers´ professional learning, experienced teachers as mentors play an important role. When reflecting on practice together with mentors, the student teachers in this particular study showed an increased understanding of the *what, how* and *why* of teaching, and as such began to develop the foundation of PCK. According to this study, it is suggested that mentor group conversations should relate to student teachers´ teaching practice and as such, provide opportunities for deeper analysis of the complex relationship between teaching and learning. Through their reflections together with their mentors, the integration of PK, CK and SMK was carefully unpacked in relation to practice, to highlight important aspects for student teachers´ professional learning. As the PCK development occurred over time, an important conclusion is that teacher education programs should enable student teachers to elaborate their collaborative and reflective skills continuously. Consequently, the goal of teacher education should be to teach student teacher to reason about their teaching and to assist them to make explicit their needs and concerns for teaching (Nilsson, 2019). There is a need for more extent longitudinal research studies discerning the relationships between the different elements that constitute teacher knowledge and how these are developed during teacher education.

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