Abstract
The study presents an alternative didactical approach to teacher education linking practice and theory through a collaborative partnership setting. Using a "small scale" teaching design in which students alternate between schools and college it was possible to show some evidence that, by following this approach, first year student teachers in a science & technology class developed teacher knowledge (as aspects of PCK).

The study identifies an example using Co-Re and PaPeR as a Resource Folio to show where evidence of developing teacher knowledge is seen. This didactical approach turns the traditional teacher education on its head and begins with a focus on practice so students alternate between school–based and college–based teaching in a cyclical fashion, and are encouraged to link theory with practice. This kind of college teaching demands a new teacher educational paradigm for which collaboration between schools and colleges is paramount.

This study indicates that a collaborative partnership setting involving college and S&T- profile schools can provide a "room for study", and that this kind of teaching design enhances the opportunities for students' to develop teacher knowledge (aspects of Pedagogical Content Knowledge) from the very start of teacher education.

AN ALTERNATIVE APPROACH FOR TEACHER EDUCATION COURSES FRAMED BY A COLLABORATE PARTNERSHIP SETTING.

Introduction
Linking theory and practice in teacher education is a challenge and international educational research has been dealing with this issue for many years. Partnership settings between schools and teacher education have been introduced to try and solve the problem (Furlong 1996).The Teacher Education programme in Aarhus (VIAUC) offers such collaboration, having developed partnerships with a number of training schools.

This study is a part of a larger on-going R&D-project concerning several approaches relevant to this partnership setting, and focuses on the possibility of offering "room for study", and so the opportunity for students to develop teacher knowledge, within the partnership setting. The aim is for the student teachers to be able to integrate college-based and school-based knowledge from the very start of their education in a way that makes it possible for them to develop the professional knowledge required for teaching, pedagogical content knowledge (PCK) (Shulman, 1986). However a collaborative partnership setting is a huge and complex frame for students, college teachers and mentors to work in, especially in a country like Denmark where there is little experience of this kind of set up in an education context. For there to be "room for study" within

the partnership setting it will be necessary to develop alternative course designs for the student teachers, that provide suitable examples of didactical approaches so the student teachers have the opportunity to develop PCK as a result of the integration of college-based and school-based training.

This article sets out to provide an example of a possible design for such a teacher education programme that uses the partnership setting as "a room for study" within the collaborative frame.

Research question
Will there be evidence that an alternative course design framed by a partnership setting supports the students' development of aspects of PCK?

I will begin by looking at what is actually meant by teacher knowledge in terms of PCK. I will then describe briefly the conditions of the partnership setting that are relevant for this case study. Next I will present a didactical approach to college-based and school-based teaching in the form of a course design that exploits the "room for study" in the partnership setting. Finally I will present some evidence that this approach to teacher education offers student teachers the possibility to transform different knowledge types by integrating college based and school-based learning and so start to develop PCK.

What kind of knowledge is the teachers'?
In traditional teacher educational settings teacher knowledge is believed to develop through the college-based and school-based teaching and training. The fields are usually taught separately and the integration into usable teacher knowledge has to a great extent been left to the student teacher's own initiative. This has often proved to be difficult because according to the special teacher knowledge, ideas and theories that influence student teachers' understanding of the link between theory and practice, this link is often tacit (Schön 1983, Korthagen 2001, Gess-Newsome 1999).

Teacher knowledge as PCK has been discussed in international educational research for the last twenty years (Berry et al. 2008), starting in 1986 when Lee Shulman (1986) defined special teacher knowledge as a construct of PCK that included,

"the most powerful analogies, illustrations, examples, explanations and demonstrations – in a word, the ways of representing and formulating the subject that makes it comprehensible for others....
...that special amalgam of content and pedagogy that is uniquely the providence of teachers, their own special form of professional understanding…Pedagogical content knowledge.... identifies the distinctive bodies of knowledge for teaching.." (Shulman, 1987, p.8)

After twenty years of Science Education Research teacher knowledge as PCK has been interpreted and elaborated by several researchers (e.g. Gess-Newsome, Appelton, Van Driel, Hashwey, Loughran, Abell). They have focused on different aspects of PCK, but there is a common opinion about four important characteristics of this kind of knowledge: PCK includes discrete categories of knowledge that are applied synergistically to problems of practice; PCK is dynamic, not static; Content (science subject matter) is central to PCK; PCK involves transformation of other types of knowledge (Abell, 2008, p. 1407). These four important characteristics of PCK and the synergistic view that PCK is more than the sum of its constituent parts will be the main analytical frame for this study.

As mentioned above teacher knowledge is a different kind of knowledge to its constituent knowledge types. Korthagen et al. (1999, 2001) try and make the distinction by referring to the knowledge types defined by the ancient Greeks such as Aristotle: Episteme and Phronesis. Episteme knowledge, in this context called theory with a capitol "T", is based on research and the type of knowledge that is central to the field of teaching in traditional teacher education: Subject matter (e.g. biology), "Fachdidaktik", Pedagogy. But more often student teachers need knowledge that is situation specific and related to the context in which they meet a problem, this type of knowledge is Phronesis, in this context named as theory with a small "t", that is a more perceptual knowledge than conceptual (Korthagen 1999, p.7). So, teacher knowledge as explained above is theory with "t" with a foundation of theories with "T", practical knowledge, Techne (praxis), and other things (e.g. ethics, emotions, tacit knowledge). All this is well illustrated by the "amalgam" metaphor (Shulman quotation above). Teacher knowledge is not a kind of knowledge that can be studied in a book, it is to be experienced and interpreted through reflections - in - action and reflections - on - action (Schön, 1983). Hashweh states that:

" We should stress....that PCK is knowledge associated with experience, and does not seem to develop from studying in pre-service teacher education programs, at least the traditional ones" (Hashweh, 2005, p 279)

Considering the knowledge types an alternative approach to teacher education would be to turn the existing college-based teaching approach on its head and start from practice and end in theory, as described in "The Realistic Approach to Teacher Education" (Korthagen et al. 1999, 2001, 2006).

"...the keyfactors is the relation between the schools in which student teaching takes place and the teacher education institute. Both staff based at the teacher education institute and cooperating teachers are part of one team that supports the professional development of student teachers" (Korthagen, 2001, p. 78)

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Changing from a traditional teacher educational setting to an alternative approach, in which the focus has shifted to the students' integration and transformation of different knowledge types requires the development of new content for the college-based training elements of the education programme. In addition it is important to consider the collaboration with the schools and the mentors as they will be the key to the whole approach as noted above (Korthagen, 2001). The conditions framed by a partnership setting will influence what opportunities student teachers have for transforming the different knowledge types into PCK.

The Partnership Setting
This Partnership setting is an agreement entered into by the training schools, the teacher training college and the municipality. In addition to the field experience period the partnership schools are obliged to involve the student teachers in other relevant activities including observations of teaching and pupils, parent meetings, staff meetings, school parties, etc. throughout the entire school year. The school-based mentors also have to take part in several meetings at the teacher training college during the year of study including planning meetings, and they are expected to take part in the preparations for the practical as well as the theoretical part of field experiences. Over all this partnership approach is very much in line with Furlong's description of a collaborative partnership arrangement:

"For the partnership to succeed mentors and college teachers will need to plan some educational settings together in an ongoing collaboration to develop a programme for the student teachers that is integrated between college and schools" (Furlong 1996, p. 44)

However the didactical approach to the partnership setting is general and complex - one could describe it as "boulder size", and one of the challenges will be to develop new approaches to the teacher training programme - at "grain size". Teaching designs that have a "grain size" focus with an emphasis on the student teachers' way of planning might prove to be a central issue for the partnership collaboration. Hashweh's interpretation of PCK as a collection of basic units called Teacher Pedagogical Constructions (TPCs) is a reasonable framework for this kind of small scale teaching design (Janssen et al., 2008). Planning, according to Hashweh, is central to the development of TPCs and thereby to the overall PCK development.

"Teacher pedagogical constructions result mainly from planning, but also from the interactive and post active - phases of teaching" (Hashweh, 2005, p. 277)

This article presents an example of a small scale teaching design for college-based teaching, and is inspired by Janssen et al.'s 2008 study among others. Janssen et al. explored a domain-specific heuristic for lesson planning and

showed the usefulness of cyclical processes alternating between school practice and college teaching.

It would be reasonable to assume that for first year students incipient PCK could start by developing TPCs or aspects of PCK. For this to happen the college-based teaching and the school-based teaching need to be integrated by taking advantage of small scale teaching designs that alternate between schools and college and offer the students an opportunity to develop teacher knowledge.

Resource Folio
Central to the teaching design is the use of a Resource Folio as a "tool" to help the student teachers bridge the gap between college-based and school-based teaching. The Resource Folio were originally developed by Loughran, Berry, Mulhall (Loughran et al. 2004, Loughran, Berry and Mulhall, 2006) as a method for exploring and representing expert science teachers PCK. The Resource Folio consists of a Content Representation, Co-Re, that represents the structured planning of the teaching and includes several points the student teachers must be aware of when teaching specific content (using knowledge about science and learners to make curricular decisions and using knowledge about science and learners to make instructional decisions) and a Pedagogical and Professional-experience Repertoire, PaP-eR, that is a complementary narrative which includes reflections on teaching. Together they are referred to as the Resource Folio (Mulhall 2003)

In this setting Co-Re is used in a slightly different way:

First as a "reverse engineering project" to make the students understand how to start building up aspects of teacher knowledge, drawing upon Subject matter knowledge (SMK), educational theories according to pupils learning, lesson planning, evaluation and so on. The elaboration of the Co-Re is meant as a basis for the further planning of the teaching sequence.
Second as a meta-theoretical approach to teaching, which was tried out by Loughran et al. (2008), who showed that it is possible to make student teachers aware of the existence of the different knowledge types in PCK.

Teaching Design
The design of the course outlined below shows an alternative didactical approach to college-based teaching in Science & Technology to enhance student teachers' teacher knowledge. The topic is the blood circulatory system – a teaching sequence lasting for two weeks. The design alternates between school-based and college-based teaching and the different steps relate to the numbers in fig. 1.

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At School
1)Students collecting pupils drawings
4) Students in field experince: Plan teaching (using the Co-Re)
5) Mentors and fellow students commenting the Students teaching using PaP- eRs in relation to the elaborated Co-Re,

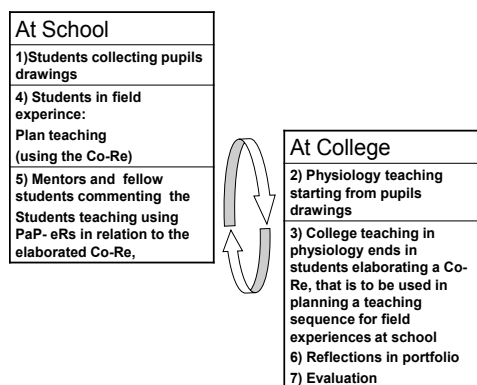| At College |
| --- |
| 2) Physiology teaching starting from pupils drawings |
| 3) College teaching in physiology ends in students elaborating a Co-Re, that is to be used in planning a teaching sequence for field experiences at school |
| 6) Reflections in portfolio |
| 7) Evaluation |

Fig.1, *The cyclical process of the study alternating between college teaching and school practice.*

1. The teaching sequence started in the school where the student teachers were supposed to identify some of the learning issues (Millar et al., 2006) that can arise when pupils try to understand their blood system. The student teachers asked the pupils, who ranged from 1st to 9th graders, to make a drawing of the circulatory system on a full size drawing of a body outline

2. The drawings were then presented and discussed at the college.

3. SMK according to the topic was taught at college, and the educational theories considered the drawings in particular in respect of the learning demands (Millar et al., 2006).

The student teachers' assignment was to plan a teaching sequence for Science & Technology that they could use in their up-coming field experience period. To be able to do this, the students had to elaborate a Co-Re based on a group discussion - the same group that they were to join for field experiences.

4. The next step for the students was to try out the teaching sequence during the field experience period. The students practice in groups of two or three and fellow students and mentors keep a diary as a narrative for reflection in the form of PaP-eR (Loughran et al., 2002) or portfolio.

5. An important part of the field experiences are the student/mentor conference meetings where the mentor discusses the students' reflections on their teaching sequences and the teacher professional competences they have demonstrated during the period. The mentors had agreed to give the students supervision in relation to the Co-Re. Mentors always keep a diary of the students' teaching if not a PaP-eR.

Theories with "t" are prevalent here.

6. Back at college the student teachers present the main points from their field experience period according to the Co-Re /PaP-eR reflections. The college teachers build upon the mentors' 'supervision by adding theories - mostly ("T") e.g. fachdidaktik, SMK and pedagogical theories.

7. The last part of the teaching design is for the students to reflect on the teaching in relation to the Co-Re at college after they have completed the field experience period. The students are supposed to write reflections in their field experience portfolios for the mentor and the college teacher to read and comment on. It is compulsory for the students to create this kind of portfolio, which has been selected as the overall evaluation tool in the partnership setting. With this approach college teaching starts with the introduction of different kinds of theories ("T") from which the students can begin to elaborate the Co-Re. The elaborated Co-Re represents the discussed theories relating to the teaching sequence that the students are supposed to teach during the field experience period. The theories with little "t" are not relevant before the field experience as they relate to the student teachers' experiences, and therefore the Co-Re is meant to be corrected and commented upon during the field experience period. In this way the Resource Folio represents the connection, "bridge", between the college-based and school-based training - placed in the partnership's "room for study".

Methodology
This particular study deals with the teaching of human physiology, which is part of the "Science &Technology" segment (a STS-subject for pupils aged 7 – 12 years). The participants in the study are first year student teachers who have selected the Science & Technology class, and who will teach "the blood system" during their field experience according to the Co-Re elaborated during the teaching sequence at the college. Five students and three mentors were involved in this particular study. The rest of the Science & Technology class had other topics to teach during the field experience period and made a Co-Re related to this other topic, and will not be a part of this case study.
Because this teaching design has been developed during the college teaching period by the researcher herself, there is a need for a flexible research design (Robson, 2002). As a consequence the study has an entirely qualitative research design, and the data was collected from observations of student/mentor meetings, interviews with mentors and student portfolios – various methods were used to promote triangulation.

Table 1 summarizes the data collected and for which purpose: One observation with three students and two mentors and one observation with two students and one mentor. The mentors took part in a semi-structured interview (Kvale, 1997) after the observations. Both observations and interviews were audio taped and transcribed.

Participants	Data source	Timing of data collection	Purpose
Students	Observation	March 2009 Weeks no. 12 -13	Prompts revealing types of knowledge and reflections
	Presentation	Week no. 14	Prompts revealing reflections using Co-Re and Pa - PeR
Mentors and Students	Observation	Weeks no. 12- 13	Prompts revealing the student learning of teacher professional concepts by using Co-Re as the subject of conversation.
Mentors	Interview	Week no. 12 -13	Co-Re as a "tool" for collaboration in the partnership setting

Table 1 *Details of data collection*

In this study I am trying to elucidate if an alternative course design in a specific teacher education situation supports the student teachers' development of certain aspects of PCK, when framed by the partnership setting. The theoretical framework for analyzing the data is first of all the four characteristics of PCK identified by Abell (Abell 2008) as described above. But by taking the incipient PCK into consideration as well as particular aspects of the PCK, TPCs (Hashweh 2005) will also be part of the framework.

In this paper I am just trying to identify examples of where there is evidence of developing teacher knowledge (TPC or aspects of PCK). As there is still data to analyse, I have decided to focus on one student teacher to see what knowledge is being developed according to the analytical frame mentioned above.
From observation 1 I have recorded a conversation between student (A) and the mentor (X) that illustrates A's reflections on practice and developing TPC for the topic under discussion:

A: *"…our goal is not that the pupils are supposed to describe the total blood circulatory system when we finish this topic. But they are supposed to know that the heart pumps blood and that we breathe. I know that we teach much more than this in class because it is meant for the bright pupils."*
X: *"There is no doubt that after the very intense teaching sequence about (digestion (prior topic)), where the pupils have been extraordinary interested and engaged they will not be able to show the same enthusiasm continuously. The heart dissection you made today did not have the same appeal though they were totally engaged in the dissection. But it was difficult for them to imagine how the*

blood is supposed to run through the heart because it is not there, and they can not see the heart pump. That might be the reason why the pupil engagement was not as great as during the last topic"
A: *"That is what I am reflecting upon. Perhaps this topic should be for 5th – 6th form instead - but the curriculum states that it ought to be 3rd – 4th!."*
X: *"You could probably break the goal up into minor parts?"*
A: *"Yes it should only be simple things to support the pre-conceptions. I will try to reduce this before the next lesson. Perhaps we should rethink our Co-Re"*

(A) has obviously experienced that theories "T" and preparation based on these do not always fit with the reality, and neither does the curriculum. It also shows the reflection process that makes A rethink the planning because of the learning demands connected to this topic were different compared to another previously taught topic.

The conversation shows the usage of theories such as SMK, fachdidaktik and professional knowledge on the basis of experience. Though it is experience shared with the mentors and the fellow students, student A shows the ability to reflect upon his planning (referring to correcting in the Co-Re), which is one of the criteria for TPC development (see Hashwey quoted above). A also shows the ability to reflect upon a teaching sequence using theories "t".

A ends this particular conversation by saying:
A: *"It has been a good "discussion platform" e.g. this discussion about the different hearts (animal types). One can make mis-judgments about the children's ability for learning the subject in a certain way but the Co-Re made us focus on the theories of Piaget and discuss the dilemma of the demands from the curriculum – so now we refer to Vygotsky and we will see when the pupils have made the last drawings (evaluation tool ed.) if we have been scaffolding enough."*

This prompt illustrates that he is able to integrate Theories "T" as well in his reflections. He demonstrates that he is capable of meeting the four important characteristics of PCK (Abell 2008)
(The relation between the outtakes from the conversation to the noted characteristics is bracketed):

- Discrete categories of knowledge that are applied to practice (SMK, curricular knowledge and pedagogy are applied in the reflection on practice).
- That PCK is dynamic (The corrections of the CoRe and after initially referring to Piaget he then finds Vygotsy's theories more appropriate).
- That Content is central to PCK (Previous topic easier for pupils to understand than the blood topic).
- PCK involves transformation of other types of knowledge (Theories with "T" and "t" have been reflected upon in the dialogue with the mentor).

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The two mentors are recognizing the Co-Re planning and X mentions in the interview afterwards that he thinks it is suitable to collaborate within the partnership setting between school and college:

(From the interview guide)
"Do you think it is worth proceeding with the work with Co-Re and PaP-eR as collaboration between college and schools?"
X: *"Very good tools and it might be possible to make it "more Danish". As a part of the college teaching it is perfect because you can also use it when the education is finished and you have well planned and reflected teaching sequences in your "bank"."*

Conclusion

What I was looking for was a new didactical approach to college teaching - that is well suited for collaboration between schools and college using the partnership setting as, figuratively speaking, a "room for study" and somewhere for the student teachers to begin developing their PCK. The idea was to concentrate on a "small scale" teaching design making it possible for first year students to have a chance to begin building TPCs or aspects of PCK as a basis for further PCK development during the rest of their education and in their practice as teachers.

Though I was only able to use selected conversation segments from one student teacher to show there is evidence of developing teacher knowledge, these excerpts seem to support the main idea in this article: That the use of Co-Re and PaP-eR in a "small scale teaching design" that alternates between college and schools might be a way to enhance student teachers' development of aspects of PCK. This kind of college teaching requires the evolution of a new teacher education paradigm, as it turns the traditional approach to college teaching on its head. By linking theory with practice, so that the initial focus is on the practice gained as the student teachers circulate between college and school experience site teacher education could be improved considerably. There are indications in this study that a collaborative partnership setting might constitute a "room" for this kind of teaching design and thereby enhance the students' development of aspects of PCK – collaborative partnerships could therefore be considered as a "room for study".

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