Practice on the line – Science Teacher Education in Denmark

Centre for Science Education

Pedagogical Content Knowledge (PCK) has been used to describe teacher knowledge for 20 years. Recently the terms CoRe (Content Representation) and PaP-eR (Professional and Pedagogical experience Repertoire) have been employed to articulate and document PCK. This extended framework has been used with science student teachers from the Teacher Education programme in Aarhus, Denmark. Case stories as well as video excerpts from school practice served as PaP-eR and student teachers' reflections provided several systematically described CoRe. Two student teachers' case stories, video excerpts from their school practice and interviews representing what the student teachers know, their actual actions and the reasons for their actions have been analysed. Results including interview and evaluation papers from the student teachers show that case-story, video and CoRe complement each other and together serve as a possible way to challenge and develop student teachers professional reflections.

Aims can be placed under two headings:
- ❑ *Student teachers learning how to teach science:* Developing the students teachers' professional knowledge
- ❑ *Synthesis of theory and practice in science teacher education:* Qualification and innovation in the teacher education didactics

The focus of this study is pre-service teacher education for primary and lower secondary school which in Denmark is an integrated 4-year programme. Training for upper secondary is organised differently. The ideal is integration of subject matter, pedagogy and school practice from day one; in reality this often proves hard to achieve. At present preparing pre-service teachers for school practice is a well functioning integrated part of the teacher education programme, but after school practice systematic approaches to use student teachers' school experiences are needed in the science subject courses.

Research Question:
How does it affect pre-service science student teachers' professional reflections if after school practice they use reflective cases, video-excerpts and systematized content representation when considering their school experience?

Theoretical Framework

Many research projects have looked at ways of documenting and developing teachers' professional knowledge. One theoretical framework is Pedagogical Content Knowledge, PCK (Shulman, 1986), but articulating links between professional teacher knowledge and practice in a way that can be represented to others has proven difficult Using an interaction of CoRe (Content Representation, linked to a particular content) and PaP-eRs (Professional and Pedagogical experience Repertoire - teachers narratives) was seen as a break-through (Loughran et al, 2004). The method was first used to portray experienced teachers' PCK, but subsequently was recommended to be used in science teacher preparation programs and research in this area in now coming (Loughran et al, 2008).

Methods and sample

The project described here involved student teachers on a geography course in their fourth, and last year of teacher education. Three different approaches were used:
- PaP-eR represented by reflective narratives and videotaped sequences from students' school practice in autumn 2007
- CoRe associated to different themes, developed by the students in groups while using their case studies and video excerpts as a starting point.

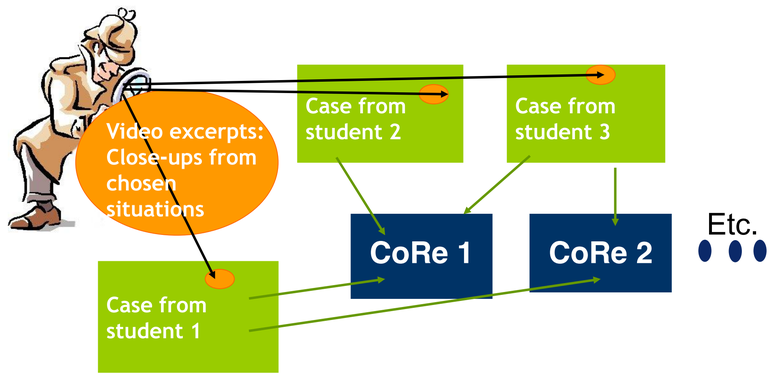
Two examples of student teachers' case stories have been analysed and compared with transcribed video excerpts from their school practice and interviews conducted after school practice. The coding categories were the subcategories from the PCK framework: Subject Matter Knowledge, Pedagogical Knowledge and Knowledge of Context as well as categories referring to professional reflections: *describe, explain and interpret* (Stockero, 2008; Sherin & vanEs, 2009).
Furthermore data included students' evaluation of the project. Semi-structured group interview were conducted in autumn 2007, while the project was still running and essays where the students responded to open ended questions were collected at the end of the spring term 2008, Data is analysed generating general units, condensing and identifying meaning.

Results

Results from analyzing the first reflective narratives provided by two student teachers, who were both teaching carbon cycle/climate change in a lower secondary setting, show that they initially focus on describing what they do as teachers in the classroom rather than interpreting how their actions contribute to school students learning. Furthermore a comparative analysis of the comments in the narratives with classroom dialogue transcribed from video suggest that what the student teachers think they are doing and what they are actually doing do not always match up. One example is a student teacher who stated in his reflections that he wanted the school students to reveal their different points of views on this socio scientific issue when in fact in practice he used an interactive but authoritative approach (Mortimer & Scott, 2003). There are however signs of the student teachers developing some professional vision (Godwin 1994; Sherin and van Es 2009) and deeper professional reflections through the project:

A reflective stance: Demonstrate competence in analyzing classroom events and identifying differences in school students' understanding of the science content and the ways in which teacher actions can affect this understanding (based on Stockero, 2008)

Furthermore interviews and essays from the student teachers' evaluation revealed their commitment and actually showed, that they were a little surprised about the enlightenment that came about through working with this kind of 'practice learning'. The reflective narratives as well as video-excerpts were reported as being very helpful learning tools by the student teachers. Video supplement narratives and show something different, more like a 'close-up'.
The student teachers' commented upon how developing a CoRe serves to give an overview and share knowledge.
A CoRe represents a common paradigmatic knowledge, but examples from the project indicate that the CoRe's which are based on the students experiences, furthermore came to represent what can be called *a situated theoretical knowledge base*, One example is that video from one of the student teachers classroom show school students not being able to differentiate the green house effect from ozone layer dilution and natural climate changes from manmade ones. These typical school student alternative frameworks has been documented in research and problems understanding concepts and science ideas in the area of climate change in spite of focus in education and in public debate is well documented in research and the student teachers had been reading research articles about this before school practice. But even so the example from the classroom seemed to arouse them in a strange kind of way, as though they finally realised that this was actually happening in their classrooms too, it was not just theory. This lead to inclusion in one of the student teachers' CoRe´s representing



↑ The three approaches in synthesis. CoRe´s we constructed representing a common knowledge base based on the individual students' cases (reflective narratives) and video-excerpts from the respective student teachers' classrooms (illustration inspired by Loughran et al, 2004).

paradigmatic knowledge based on educational research, but also situated in a lived and shared classroom experiences

Conclusions and implications

Use of the three approaches: Students' reflective narratives, video-sequences as close-ups and Co-Re as a systematic view on teaching a given content to a given group of school-students seems to point at a promising direction to follow when developing teacher education. The student teachers develop their individual reflection on action as well as reflection within the community of learners and through this method the student teachers analysied content and didactics in a synthesized way, which can be seen as a first step in developing PCK. Further examination of the methodology in other science subject courses and in student teachers bachelor projects are running at the moment including further examination of the particular use of video-based "artefacts of practice".

A short Bibliography

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One CoRe from the project: Teaching Climate Change in lower secondary school 8th grade. Ten different CoRe´s were constructed by the student teachers →

Climate Change — Big Science Ideas → / Teaching Climate Change ↓	There has in geological time as well as in historical time been climate changes caused by astronomical reasons, different amount of sunspots, big vulcanic eruption etc. During the last 50 years we have seen higher average temperatures which with a probability more than 90 % (according to IPCC) is caused by humans.	In the lower part of the atmosphere, the troposphere, there are some gasses (CO_2, CH_4, H_2O(g) etc.) which allow short wavelength radiation from the sun to pass through, but which absorb part of the spectrum of long wave radiation emitted by the earth. When the concentration of these gasses rises, the radiation-balance can become stabilized at a higher level, and the earth gets warmer	Higher in the atmosphere - the stratosphere - is a zone with a concentration of ozone (the ozone layer). The ozone layer absorbs parts of the UV radiation (short wavelength) spectrum emitted by the sun and thereby is important for life on earth. Depletion of the ozone layer can have negative consequences, such as an increased incidence of skin cancer etc. But this phenomenon does not contribute to what is called the Greenhouse Effect. Depletion doesn't directly affect the climate on earth.	The Greenhouse Effect is important for life on earth. Without the Greenhouse Effect the average temperature would be approximately 18 ° C and there would be greater variation between day and night time temperatures. Problems arise, however, if the Greenhouse Effect is increased. This can occur, for example, with the burning of fossil fuels etc.
What do you intend the students to learn about this idea.	To know in a broad, but not detailed way, that we have seen climate change (astronomical) in a relative long cyclus and to know that variation in sunspots can cause climate change, as a possible example the relatively warm Middle Age.	To know that electromagnetic radiation is classified into types according to its frequency and wavelength.	To be able to distinguish the difference between the problems associated with depletion of the ozone layer and an increased Greenhouse Effect.	To understand that the environmental problems that is discussed in the news and which is believed to result in measurable phenomena such as rising sea water levels or melting ice floes is an increased Greenhouse Effect.
Why is it important for students to know this.	To be able to follow the public debate, in which the question of whether or not the heating we see now is manmade or a natural phenomenon, like the climate changes the earth experienced before industrialisation.	To gain a greater understanding of how the Greenhouse Effect arises - it is difficult to understand why some kinds of radiation can pass through the atmosphere to the earth's surface, while other types of radiation are 'trapped'	Because these two effects are often mixed up.	To be able to understand that CO_2 is not a poison but an important part of the atmosphere, and to understand the effects of an atmosphere on the earth and on other planets.
What else you might know about this idea (that you don't intend students to know yet).	Recent analysis of ice-cores has revealed that there are often significant fluctuations in climate at the end of an ice age, which may be caused by changes in the oceans thermohaline circulation.	The wavelength of electromagnetic radiation depends on the temperature of a body (and the sun is warmer than the earth)	In the history of the solar system the ozone layer didn't evolve until after the start of oxygen producing photo synthesis which began with the first life in the oceans, and living things didn't evolve on land prior to the development of the protecting ozone layer	The atmosphere on other planets in the solar system: It is a Greenhouse Effect that makes Venus very hot. Mars may have had a more concentrated atmosphere at the start of the solar system's history - and this could have created conditions suitable for the development of water (l) and maybe life.
Difficulties / limitations connected with teaching this idea.	It is an area where science (for example (IPCC) speaks in probabilities, this can be hard for students to grab. Climate change in geological time is a complex field.	Abstract thinking!	The students may have seen ozone mentioned as a greenhouse gas - but this is in the troposphere, not in the stratosphere.	
Knowledge about students' thinking that influences your teaching of this idea.	There ia a great need for abstract thinking when trying to understand the different time ranges.	Research shows that only a few students can distinguish between the radiation from the sun and that from the earth.	Research on student thinking reveals that many students mix up the effects of the depletion of the ozone layer with the changes caused by an increased Greenhouse Effect.	
Other factors that influence your teaching of this idea.				This is connected to the carbon cycle - which the pupils ought to become acquainted with in physics as well as in biology and geography.
Teaching procedures (and particular reasons for using these to engage with this idea).	The story of The Earth on a time-line can be a help when trying to understand the relatively short time scale over which manmade climate changes have taken place.	Models of the atmosphere can be used to illustrate this phenomenon. For example, it is possible to experiment with heating CO_2 in a glass.		
Specific ways of ascertaining students' understanding or confusion around this idea.	Use af concept mapping can reveal student understanding.	The students' drawings of an atmosphere and student/teacher discussions about these drawings can reveal whether they can identify which is the in coming and which the out going radiation.	A double sided logbook that the students can use for drawing or writing can help avoid mix-ups surrounding terminology or misunderstood concepts. The students can explain their understanding in everyday language on the left and then write the explanation in 'science language' on the right.	

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'Teachers professional vision involves the ability to notice and interpret significant interactions in the classroom' (Sherin and van Es, 2009)