

# Meaning-making from CPD – developing practice in own classroom and as a peer in the local science PLC

Birgitte Lund Nielsen <sup>1</sup>

<sup>1</sup> VIA University College, Ceres Allé, 8000 Aarhus C, Denmark

## Abstract

Continuous Professional Development (CPD) can be crucial in qualifying teaching, and student learning. Extant research suggests consensus pertaining to the core features of effective CPD including content focus, active learning, coherence, duration, collaborative activities and collective participation. This paper presents findings from a case-study in the frames of a large scale, long term CPD program designed according to these criteria. Science teachers from 42 schools participated from 2012-15 in CPD-activities changing rhythmically between network seminars, collaborative inquiries organized by the local professional learning communities, and individual trials. The research examined the development over time of the case-teacher's reflections and new enactments in own classroom and in collegial interactions. A multiple methods design with repeated observations and interviews was applied. Findings reveal a development where the teacher's reflections in relation to teaching primary science grew to be more confident and personalized, including experiences from her own class, and more detailed regarding supporting student learning. Furthermore, over time, a closer connection between the teacher's reflections and enactments in own classroom could be identified. Decisive aspects were about 1) alignment between the teacher's beliefs and the approaches taken in the CPD program, 2) the support to try out new approaches in own classroom and in collaboration with colleagues, and, 3) the autonomy handed over by the school-leader e.g. to develop the local science team to also involve primary science teachers. The case-study exemplifies the complex interplay between individual and collaborative agency among teachers, and contextual factors like leadership, in starting and sustaining a positive spiral.

**Keywords:** Continuing professional development; primary science teaching; professional learning communities; inquiry based teaching; student learning

Corresponding author e-mail address: [BLN@via.dk](mailto:BLN@via.dk)

## Introduction

We know from research that continuous Professional Development (CPD) can be crucial in qualifying teaching, and that CPD supporting teachers in improving, modifying and innovating their teaching can be a determinant factor for student learning (Luft and Hewson, 2014). Extant research suggests consensus pertaining to the core features of effective CPD including content focus, active learning, coherence, duration, collaborative activities and collective participation (Desimone, 2009; Van Driel et al., 2012). This paper presents findings from a case study following one science teacher and her students over three years during the school's participation in a large-scale, long-term CPD program with former documented results at the quantitative level (Nielsen, 2015). The design of the CPD program, involving teachers from 42 schools located in 5 Danish municipalities, referred to the consensus criteria acknowledging teachers' situated learning in professional learning communities (PLCs) (Stoll, Bolam, McMahon, Thomas, and Wallace, 2006). A core feature was a rhythm with consecutive iterations of CPD-seminars followed by individual inquiries in own classroom and collaborative inquiries in the local PLC (Timperley, 2011). So, importantly, a part of the CPD activities were embedded in the teachers' daily work (Luft and Hewson, 2014). The content of CPD-seminars was informed by research in science education, e.g. focusing on how to support school students in working inquiry based and with dialogue about science phenomena, acknowledging their typical alternative conceptions (Bransford and Donovan, 2005) (more about this particular CPD program called QUEST below). Previously reported quantitative results from the QUEST program have shown positive changes both in teachers' collaboration and classroom practice, however with great variation between schools - and interestingly a correlation between level of changes in collaboration and classroom practice (Nielsen, 2015). Furthermore, some (delayed) correlation between schools with the most sustained PLC activities and student test results in science can be emphasized based on the quantitative data (Nielsen, 2017). These findings highlight the need for more in-depth knowledge about development over time in individual classrooms at schools participating in large-scale CPD initiatives, also emphasized by van Driel et. al (2012) and Luft and Hewson (2014). This paper focuses on such an in-depth case study following one teacher through the CPD-program.

## Background

### *Professional learning communities*

Over the last decades there has been a shift from mainly viewing CPD as an individualistic activity towards emphasizing a school's collective capacity as a more important focus (Little, 2006). Research

has steadily converged on the importance of teachers' joint work and shared responsibility working in some kind of PLCs (Stoll et al., 2006). Collaboration among peers and within educational communities can take many forms. Stoll et al. (2006) emphasize some key characteristics of a successful PLC: 1) Teachers developing shared values and vision, 2) a focus on student learning, 3) teachers being involved in reflective professional inquiry, and 4) collaboration and collective responsibility.

### *The QUEST project*

QUEST ("Qualifying in-service Education of Science Teachers") was a large-scale, long-term CPD-project involving 42 schools from five municipalities in Denmark. All in all, the four-year project, which ran from 2012-2015, involved 450 science teachers. QUEST activities were inspired by and designed according to the consensus criteria mentioned in the introduction. So, for example, CPD activities involved both 1) workshops and course-activities, 2) the support from the program for teachers' situated learning organized in PLCs at the participating local schools, and 3) the support from the program for activities in local networks of schools. The overall purpose of QUEST was to develop a sustainable model for CPD, acknowledging the importance of professional capital and bottom-up development (Darling-Hammond, 2005; Hargreaves and Fullan, 2012). So - a program of alternating network seminars and "collaborative inquiries" between seminars was designed as a mean to stimulate collaboration among science teachers and embed the CPD activities in the teachers' daily work and acknowledge their experiences (Luft and Hewson, 2014). This is called the QUEST-rhythm. Activities between seminars were basically organized by the local PLC (and networks of local PLCs), but it also involved individual teachers trying new tools and refined approaches in their classrooms, and collecting "data" and artefacts representative of their students' work to share with their colleagues. The facilitation of teacher inquiries was inspired by the models proposed by Timperley (2011). In practice various "levels of teacher inquiry" could however be observed: one local PLC might talk about this as "an assignment" from the QUEST program and in other instances we saw more ownership and genuine inquiry in a knowledge building cycle as described by Timperley (2011). These differences among schools are described in Nielsen (2015; 2017), here just mentioned to emphasize that the reference to "a local PLC" covers various degrees of genuine PLC-characteristics according to the key elements mentioned by Stoll et al. (2006).

The QUEST-project was divided into two main phases, a 2 ½ year implementation phase and a 1 ½ year institutionalization phase. In phase 1, the implementation phase, the primary and lower secondary science teachers participated in one or

more of four consecutive course-modules, each following the QUEST-rhythm. The content of the course-modules - theory and practice for qualifying science teaching - was informed by research about student learning in science (Bransford and Donavan, 2005). So, importantly, the program was informed by research both at the design and at the content level. For example, the teachers in module 1 worked with inquiry based science education (IBSE) (Minner et al., 2009), and in module 2 with the principles of addressing pre-conceptions and supporting students' knowledge of what it means to do science, e.g. by using tools like students' annotated drawings (Nielsen, 2014). The course modules also addressed issues connected to learning progressions in science, and presented and supported the trial of concrete methods for collaborative teacher inquiries like lesson studies, peer-observation and video-clubs (Little, 2006). The course modules in the implementation phase were organized as full day seminars, where the teachers were introduced to and tried out new tools, materials, and approaches, followed by a period of individual and collaborative enactments in local practice, and culminating in the sharing experiences at the next meeting of the network. In the implementation phase this rhythm aimed to support teachers in developing individual and collective efficacy for continuously developing science teaching locally. This is in line with Bandura (1997) who emphasizes personal and social change as complementary and both teachers' personal and collective efficacy as crucial for changes to be sustainable. In phase 2, the institutionalization phase, support from the CPD providers was gradually withdrawn with the aim of empowering local schools and communities to engage in continuous development. Local municipal consultants, typically experienced science teachers working a day per week as a consultant, played an important role in this phase, and in principle the institutionalization could - and did to some degree - follow different models in the five municipalities. But all municipal networks chose to continue to follow the QUEST-rhythm to frame their activities in (and after) the institutionalization phase.

### ***Teacher's meaning-making***

Building on teachers' professional capital (Hargreaves and Fullan, 2012) and supporting their agency (Bandura, 1997), e.g. by having a systematic focus on bottom-up development balancing the top-down CPD-activities (Darling-Hammond, 2005), are known to be very important for the sustainability of teachers' work with new teaching approaches advocated in a CPD-program. So, more in-depth knowledge about teachers' experiences is needed to evaluate the success of such inquiry-oriented and collaborative CPD programs. What works under what circumstances and for whom? This means calling for research looking into the teachers' perceived outcomes, their enactment of new methods in the classroom, and their reflections on

this and on the collaboration with colleagues. The main aim of the present research is with this reference to examine an individual teacher's meaning-making (Nielsen, 2012) in the context of the large scale, longitudinal, collaborative CPD program QUEST.

### **Research questions**

RQ1: What outcomes does the case-teacher identify from the CPD-program, including the PLC activities with science colleagues at the local school?  
RQ2: What characterize the teacher's reflections and enactments over time related to teaching science and supporting students' learning of science?

### **Methodology**

#### ***A case study in a mixed method design***

The full mixed methods research design in the QUEST-project included a collection of both quantitative and qualitative data - results from a five time repeated questionnaire has already been reported (Nielsen 2015; 2017). The data gathered from the questionnaire, along with observation-notes from of course activities were assembled in a protocol describing each of the schools. Teachers from five schools were selected for more in-depth case studies. The case studies served to understand in-depth some of the quantitative results. Cases were selected based on diversity sampling: school size, town/rural etc. So, a diverse range of case-teachers were followed in the full research design, whereas data from a single case is presented here. The case-teacher followed, here called Anna, was sampled as being a rather novice teacher with 4 years of experience - not a science specialist, however specialized in primary science besides other more humanistic specializations, and from the beginning of the project only teaching one class of primary science.

#### ***Data-collection***

Data-collection included five times repeated classroom observations and teacher interviews in the period 2012-15. A combination of a rubric and a text-memo was used to document observations. Post lesson interviews followed an interview-guide. To answer RQ 1 additional data was observations from CPD-seminars and local PLC-meetings, and to answer RQ 2 additional data was repeated interviews with a group of four school students followed from 4<sup>th</sup> to 6<sup>th</sup> grade, and sampled to represent variation in the level of interest in science and gender.

#### ***Data-analysis***

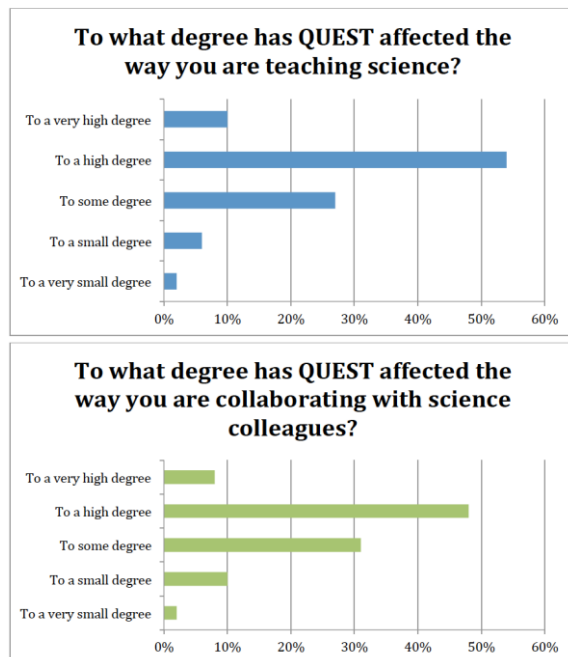
Teacher interviews were analysed using a meaning-making model developed based on the interconnected model of teachers' professional growth from Clarke and Hollingsworth (2002), but including also a collaborative domain (Nielsen, 2012). So, teacher utterances in the repeated interviews were identified as belonging to the five domains: Domain of Practice, Personal Domain,

External Domain, Domain of Consequence or Domain of Collaboration, and are represented in consecutive meaning-making maps, illustrating a second level of analysis connecting the domains with arrows of reflection or enactment.

Data from group interviews with students were analysed in an iterative process of thematic and data-based categorisation and coding (Cohen, Manion and Morrison, 2007).

**Findings and discussion**

In all interviews, the case teacher Anna referred to a high level of perceived outcomes from the CPD. In particular, she referred to outcomes from learning more about and trying out in her class concrete ideas for a more inquiry based approach to teaching science in the CPD workshops, and to sharing these new experiences with colleagues. In the last questionnaire, where answers from all teachers are represented in figure 1, Anna marked a very high degree of effect from QUEST on her own teaching and a high degree of effect on the local collaboration.



**Figure 1:** Examples from the quantitative results (Nielsen, 2015; 2017). There is a moderate positive correlation ( $R=0.55$ ) between how the individual teachers rated changes in own teaching and in collaboration.

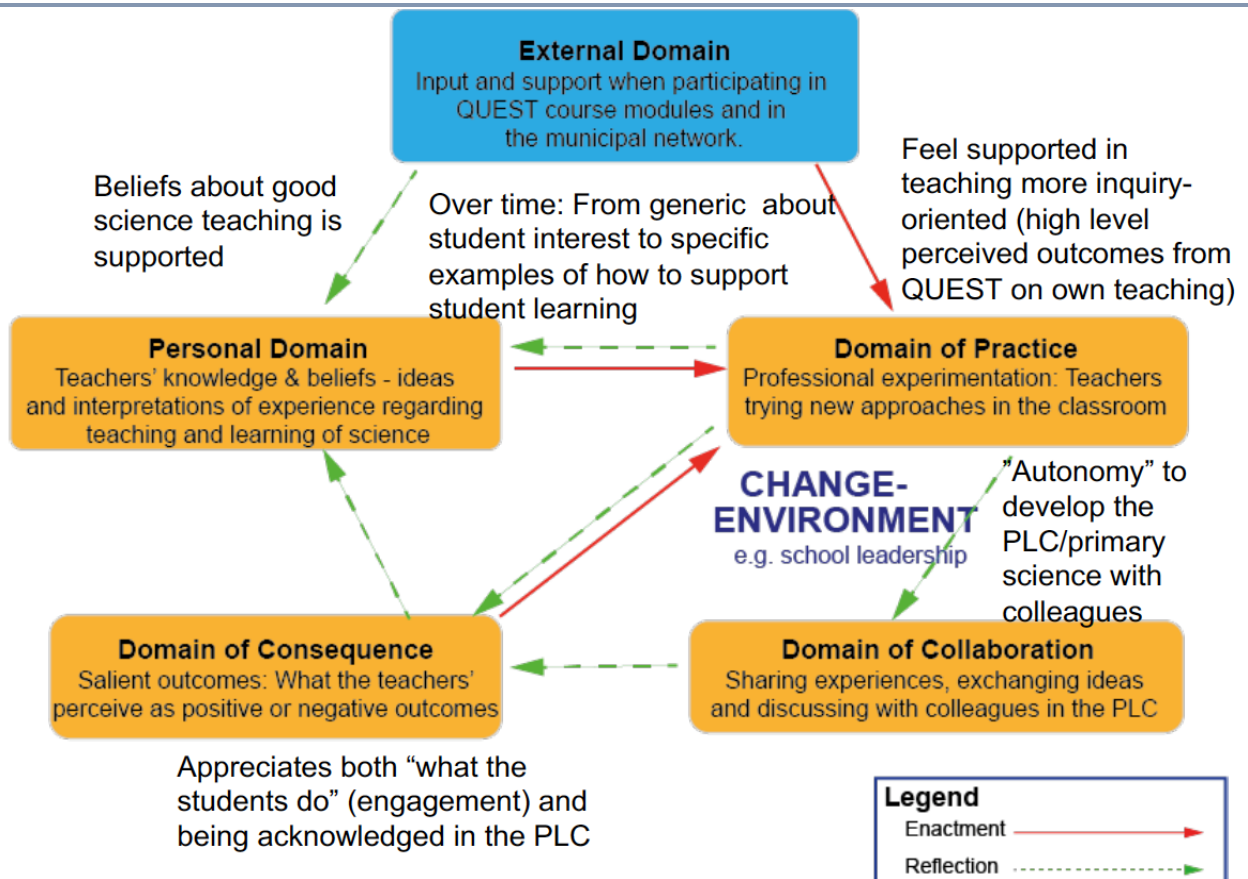
**More detailed, personalized and confident reflections over time**

In the first interview at the beginning of the project Anna referred, in general terms, to

supporting student interest as the most important issue in relation to teaching science, but she found it hard to exemplify how this might be done in relation to her own teaching. However, she emphasized that students need to have hands-on activities in science to be motivated. Over the following years Anna's reflections in relation to teaching primary science developed to be more 1) detailed, 2) personalized, and 3) confident. More detailed for example in relation to her arguments about how students' interest and learning can be supported when working inquiry-based: That it was important not only to think about inquiry in science as hands-on activities, but a focus on minds-on activities was likewise important, when talking about IBSE (Minner et al., 2009). For example, in the last interview at the end of the implementation period, Anna emphasized how she scaffold students' dialogue by using drawings and concept-cartoons, and how she supported the students in the inquiry process by using rubrics, where they had to argue using their own words about the science phenomena, what in particular they wanted to examine, what were their initial hypotheses, how did they propose to examine this particular phenomena, and what was their interpretation of the findings. So, Anna's initial beliefs about what constitute good science teaching was not challenged, but she gradually gained experiences to argue about what could be challenging - areas where teacher scaffolding was crucial - and what exactly the benefits could be from developing the teaching towards a more inquiry based approach. Furthermore, over time Anna began to refer to concrete examples from her own classroom when talking about how to support students' interest and learning: her reflections grew to be more personalized and internalised instead of referring to pedagogical ideas formulated in broad terms.

This development was identified when analysing the interviews, and it was confirmed by the classroom observation. Further, a closer connection between Anna's reflections on the teaching of primary science and enactments in own classroom could be identified. This is illustrated in the meaning-making map in figure 2 connecting personal domain with the domain of practice with both reflection and enactment arrows. A reflection arrow from external domain represents the basic beliefs about good science teaching, and an enactment arrow from external domain represents Anna's perceived outcomes and experience of support from the CPD-program in relation to continually qualifying the use of inquiry based approaches in her classroom.





**Figure 2:** Meaning making map summing up from the repeated teacher interviews with the case teacher Anna. The model is developed based on Clarke and Hollingsworth (2002), but with also a domain of collaboration (Nielsen, 2012).

Based on the repeated classroom observations this development can be characterized more as an evolution than a revolution in relation to structuring and scaffolding student inquiries, but these small changes seemed rather important in relation to mediating her students' learning activities and dialogue about own experiments. These findings are supported by repeated interviews with a group of students.

In relation to the change environment the case-school was characterized by an in some way absent school-leader. He did not participate in PLC meetings as school leaders from some of the other QUEST-schools with the most positive development did. He was however placing trust and "handing over" autonomy to Anna and her colleagues from primary science and (indirectly) supporting them in pursuing a closer cooperation with colleagues teaching lower secondary science. When the QUEST project started, only colleagues teaching science in lower secondary were part of the school's science-PLC. Anna however, together with two other primary science teachers, made a suggestion for the school leader to include also the primary science teachers in this local science-PLC. They used the school's participation in the QUEST program as one of the arguments and they were given rather much autonomy by the school leader to develop a way of in-cooperating this new integrated science-PLC.

Before QUEST the lower secondary science specialists were in general seen as "the resource in science who could inspire and support colleagues". This grew to be more equally divided as some lower secondary science teachers were inspired at PLC-meetings where the primary science teachers e.g. urged them to try some IBSE activities themselves, together in the teacher group, and illustrated what they had tried in primary science. Over the years in QUEST Anna developed from having her teacher-identity mainly attached to teaching Danish and some humanistic subjects and only teaching one class of science to gradually having a central role as a resource-teacher among colleagues from both primary and lower secondary. At the end of the project she was teaching science in 6 different classes, as well as being involved in co-teaching with a colleague in his class of lower secondary biology to help him develop the teaching to be more inquiry based. This complex development is illustrated in the meaning-making map (figure 2). Anna emphasized in the last interviews that she felt acknowledged by the colleagues also those she before had seen as more science-specialists than herself. These reflections illustrate how mastery enactive experiences (Bandura, 1997) in collaboration can add to the positive experiences from her own classroom leading to further enactments: represented in the domain of consequence (figure 2).

Summing up - the quantitative results from QUEST have shown a positive correlation between teachers' perceived outcomes in relation to own teaching and the outcomes in relation to what is reported as a more fruitful local collaborative culture (figure 1). This case-study illustrates one example of how this interconnected development might look like, and how a positive spiral can be started and sustained in the interplay between trying out things in own classroom, sharing experiences with colleagues and taking an active role in the development of the collaborative culture in the PLC. Not all QUEST schools and teachers experienced the same development, but across cases the research has pin-pointed, that a positive spiral needs to be started and sustained, and that teacher agency (Bandura, 1997) is central to do so.

### Conclusion

Decisive aspects in starting and sustaining a positive spiral in the present case were particularly about 1) alignment between the teacher's beliefs and the approaches taken in the CPD program, 2) the support to try out new approaches in own classroom and in collaboration with colleagues as part of the CPD and, 3) the responsibility handed over from the school leader e.g. to develop the local science PLC to also involve primary science teachers. The case-study exemplifies the complex interplay between individual and collaborative agency among teachers, and contextual factors like leadership, in starting a positive spiral at a school participating in a CPD program.

Teacher beliefs reveal their understandings of knowledge and learning and how they *may* enact their classroom teaching, but not what they actually *do*. The findings from this case are specifically connecting beliefs about inquiry with enactments when teaching science among others. Over time the teacher expressed her beliefs as more based on own experiences, more detailed in relation to student learning, and more aligned to what she actually did in her classroom teaching. The case-teacher Anna grew to be an active learner and co-designer in the CPD (Luft and Hewson, 2014), and the confidence to do that gradually grew from mastery enactive experiences both in her own class and when sharing ideas with colleagues. Seen together with the previously reported data from this program the case study contributes to an in-depth understanding of factors encouraging the use of input from CPD, and the (delayed) effect from CPD, to teacher reflections, to new enactments, and ultimately to student learning. This is about external domain – certain designs of CPD – but certainly also about school contextual factors in this case e.g. the autonomy-supporting leadership and the interplay between individual and collaborative enactments and reflections.

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