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Between Teaching and Researching: Envisaging Ownership Benefits of Involving Teachers from an In-service Teacher Training Program in the PARSEL Project

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ABSTRACT: The Danish PARSEL team included 5 teachers from the region of Southern Denmark, of whom two enjoyed special status. These two teachers have been trained to develop, implement, and evaluate interventional modules similar to those of PARSEL, through a one year full-time equivalent master's degree program in science and mathematics education. This program took its lead from the model of educational reconstruction, and this engaged the participating teachers in having an intimate contact with researchers in implementation and evaluation processes very similar to the trying out phase of the PARSEL project. This paper presents the teachers' background in the form of the masters degree program; it presents the teachers comments on the PARSEL project and the individual modules; and it moves to discuss and envisage special outcomes regarding ownership of PARSEL modules for intimate partnerships between teachers and researchers.

KEYWORDS: Educational reconstruction, professional development, teacher-researcher collaboration

Introduction

The Danish partner in the PARSEL consortium – the University of Southern Denmark –involved 5 teachers from the region of Southern Denmark as key PARSEL partners for the implementation and evaluation phase of the PARSEL project. The teachers started the implementation of 10-15 PARSEL modules during the fall of 2008. Short of conducting a large scale implementation and evaluation, the Danish consortium aimed at a focussed in-depth study involving teachers at a higher level of reflection. Needless to say, each European or Israeli teacher involved in the PARSEL project was considered as being special. The immense time and efforts put into the initial implementation and annotation of PARSEL modules called for specially-driven and energetic teachers. In that sense, the PARSEL teachers paved the way for smooth and easy ownership of PARSEL modules by their col-

leagues in the future. Beyond this, two of the Danish teachers among those involved in the PARSEL project enjoyed a special background. The short story of this background is that these teachers have been trained for nearly two years to develop, implement, and evaluate interventional modules similar to those in PARSEL. In the following, the longer story of that background is unfolded and some of the peculiarities concerning the background of the teachers are presented. Further, some special outcomes regarding ownership of PARSEL modules in the Danish context are envisaged.

Science Teachers of the Future

Since November 2006, the Centre for Science and Mathematics Education at the University of Southern Denmark has managed the pilot project *Science Teachers of the Future*[1]. This pilot aimed at the development of an in-service professional development education program. The pilot and the resulting educational program had the form of a one year full-time equivalent (60 ECTS) master program conducted over 4 semesters. The pilot project was initiated with the participation of 24 science and mathematics teachers from the region of Southern Denmark.

The strategic aim of the program was to provide a sufficient number of teachers with skills and competences in helping students to learn mathematics and science in a rational way, reflecting the need to improve the proficiency and competence level in the Danish lower secondary school. Very much similar to the philosophy of the PARSEL project, the *Science Teachers of the Future* project involved teachers as key partners in the development of the master program by involving teachers in trying out and taking ownership of the sequences developed in the program. When teachers were working together in ways that provide professional support from one to another, the outcome was improvements in practice (Loughran, 2006). Reflecting about practice through collaboration with trusted colleagues made the tacit explicit, and developed knowledge, skills, and expertise in practice. The teachers' collaboration and discussions of practice offered alternative interpretations of shared experiences. This led, according to Loughran (2006), to four issues that were significant in shaping the teachers' understanding of and approach to practice: (i) seeing into experience through professional critique, (ii) recognizing different types of teaching decisions, (iii) recognizing differences between action and intent, and (iv) exploring the value of co-teaching. As a consequence, the master program was organized as workshops and open seminars with the purpose of making it possible for the teachers to share their ideas and experiences with their colleagues, and have contacts with academic experts in the fields of science, mathematics, and educational research.

Theoretical Framework

To be sure, the PARSEL model and its manifestation in the individual PARSEL modules could not, by itself, sustain the expected change in teaching practice across Europe. This is so, even though the majority of teachers were interested in

1. The project was financially supported by the *European Social Fund.*

improving and enriching their teaching methods. As Tyack and Cuban (1995) have pointed out, teachers need help in adapting, or developing new instructional practices. McLaughlin, Black-Hawkins, Brindley, McIntyre, and Taber (2006) emphasized the importance of inclusiveness. Experiences from the past century, both in schools and in research, indicated that innovations in schools could more readily survive if the recipients, mainly the teachers, have been involved early in the decision-making process. This insight was also supported by recent research into teacher identity, indicating that a pivotal point in producing a positive change of identity involved first and foremost a *transformation* from an asymmetrical relation of teachers to educational researchers to a symmetrical relation in which the teacher perceived him/herself as being on par with the researcher (Bjuland, Cestari, & Borgersen, 2008). Needless to say that the involvement of teachers in the PARSEL project was a strong step in this direction, but the Science Teachers of the Future project went even further.

Taking the perspective of change in teaching practice and the use of research in the process, Richardson (1990) argued that research should provide teachers not just with findings in the form of activities that work, but also with ways of thinking, and empirical premises related to thinking and learning. In this way, research became a basis for the development of justified practices with which the teachers might experiment in their classrooms. Teachers were thus able to exercise considerable control over the decision of whether and how to implement a change in teaching practice, and any intervention would need to acknowledge this control, and help teachers to understand and be held accountable for the intervention. This called for a strategy for teachers' professional development aimed at motivating teachers to use more effective practices. According to Mamlok-Naaman, Navon, Carmeli, and Hofstein (2005), action research is an effective means of helping teachers to reflect on their practice, if they are provided with an environment of support, collegiality, and a chance to collaborate with researchers and other teachers. Teachers experienced a new dimension of professional development through action research in three main areas:

- implementation of change through action research;
- having a sense of being a part of professional community; and
- having contacts with academic experts.

Michelsen (2006) pointed out that in design-based educational research, teachers and researchers collaborated to produce meaningful change in the classroom practice. This meant that goals and design constraints were drawn from the local context, and led to the suggestion of a design strategy that deliberately created opportunities for the stakeholders to influence the design process and focus on the adaptation of already existing practices. The design process thus called for the cultivation of the ongoing relationships between teachers and researchers. In this context, pre-service as well as in-service teachers usually play a crucial role. With the rationale of supporting teachers to participate in and contribute to the design process, there is a clear-cut reason for including instructional design in teacher education. Clearly, there is a strong coincidence between the dynamic processes involved in such action research cycles and the implementation and evaluation of

PARSEL modules, and it is our hope that the Danish implementation phase will benefit greatly from this.

The educational philosophy of the master's program offered by the University of Southern Denmark is based on the view that educational research is a design science. In this view, the aim of educational research is to reduce uncertainty of decision making in designing and developing educational interventions. The term intervention then serves as a common denominator for products, programs, materials, procedures, scenarios, processes, and the like (van den Agger, 1999). The Design-Based Research Collective (2003) described interventions as enacted through the interactions between materials, teachers, and learners. Our basic motive for considering science and mathematics education as a design science stemmed from the experience that traditional approaches in science and mathematics education - with their focus on descriptive knowledge - hardly provide the teachers with useful solutions for a variety of problems in teaching of science and mathematics.

The model of *educational reconstruction*, developed by Kattmann, Duit, Gropengießer, and Komorek (1996), offered a promising frame for involving teachers in action research with a focus on designing, implementing, and evaluating innovative instructional sequences, and was adopted as the underlying educational approach. This model proposed a cyclic process of analyzing scientific content, studying student's perspectives, and developing sequences of instruction. Two reasons for choosing this approach could be spelled out. First, the triadic model of educational reconstruction allowed that change-of-practice processes could be vehicles for connecting knowledge of scientific and pedagogical content, and classroom practice. Thus, the model would, in theory, facilitate the development of warranted teaching practices. Second, the model was originally developed as a research model for science education research, and, as such, it fitted naturally with the aim of equipping the participating teachers, so as to implement action-research-type projects. According to the model of educational reconstruction, what the science educator did in this process was to *reconstruct* scientific knowledge "in order to make the science point of view understandable and meaningful to learners" (Kattmann *et al.*, 1996, p. 3). And it fleshed out a beneficial process of reconstruction involving (i) analyzing content structures so as to identify salient concepts and their relations; (ii) investigating students' pre-scientific conceptions – both cognitive and affective; and (iii) developing instructional sequences on the basis of the first two steps (Kattmann *et al.*, 1996).

In the context of the educational program offered by the University of Southern Denmark, an approach was adopted through which the participating teachers were guided by means of multiple cycles of developing, implementing, and evaluating instructional sequences. The model of educational reconstruction came to the fore in the process of developing such sequences. And from this respect, the model of reconstruction shaped the content and curriculum of the degree program. In order to properly analyze content structures, one must have a firm background of content knowledge across mathematics and the science subjects. Being able to reconstruct a specific content meant in the first instance to be able to navigate the field to which that content belonged. Further, a proper inve-

stigation of student's pre-scientific conceptions required both analytical investigatory tools as well as background knowledge in the dialectics of the psychology of learning. To this end, the degree program offered to participating teachers an analytical tool box of scientific and mathematical content knowledge, and a background in historical and contemporary educational research. In addition, the participating teachers were introduced to multifarious tools to render successful their reconstruction – such as insights into the usage of a variety of teaching formats and the usage of alternative learning environments. It was thought that the *parallel expansion* in the dimension of subject matter knowledge and in the dimension of educational tools would equip teachers properly for the development, implementation, and evaluation of instructional sequences, as indicated in Figure 1. This process was thought to result in dissemination of the sequences, increased networking of the participating teachers, and teachers' reporting to academic experts, to each other and other teachers, facilitating a lasting way of sharing their ideas and experiences with their colleagues, and having contacts with academic experts.

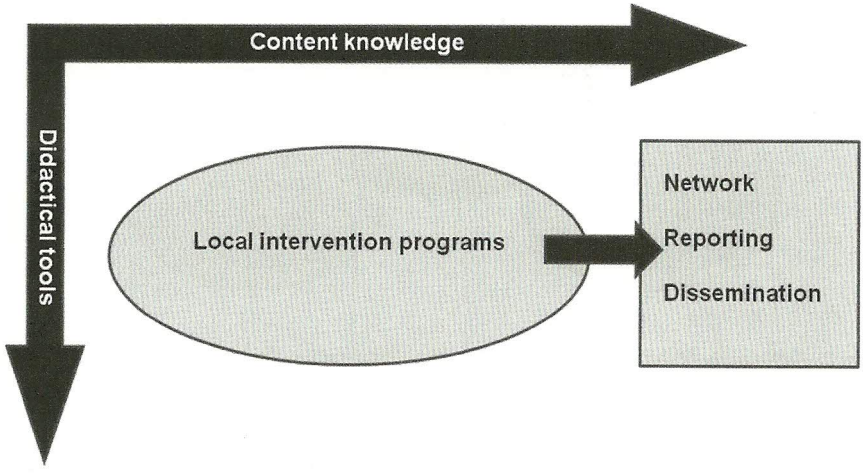

Figure 1. A Diagram of the Educational Outlook Behind the Project Science Teachers of the Future in Denmark.

PARSEL in the Context of Science Teachers of the Future Project

During their studies, the participants of the Science of the Future participated in threee semesters each of which constituted an individual unit with an overall theme. In each semester, the teachers attended workshops, discussion groups, seminars, and lectures, while each semester was concluded with an examination.

Reflection has probably been the mostly used word in literature about teacher education. But, reflection has been used with various meanings. We adapted the idea introduced by Korthagen, Kessels, Koster, Lagerwerf, and Wubbels (2001), where professional learning based on systematic reflection was related to the use of action research by teachers. In order to prepare the teachers for action research

and to facilitate processes of educational reconstruction, the program offered a wide range of input, see Figure 2 for an illustration of the types of input. First, by introducing the teachers to the most recent research in different science fields, the teachers not only familiarized themselves with the state of the art in research, but they also learned how scientists work to produce new results. This aspect was provided by lectures, workshops, and seminars by and with researchers in science and in science and mathematics education from the University of Southern Denmark. Two key themes have been continuously stressed in this respect: (i) the historicity of science and mathematics in general and the histories behind the concurrent research products; and (ii) the everyday work of a science and/or mathematics researcher.

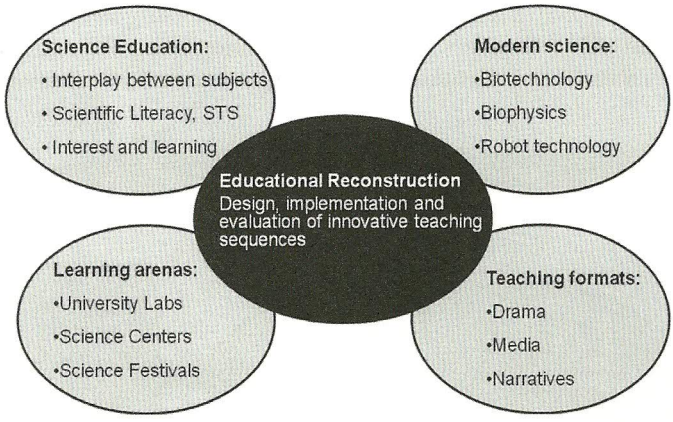

Figure 2. A Diagram of the Different Tools Offered to Teachers for Their Educational Reconstruction.

Second, the teachers were introduced to educational theories specifically aimed at science and mathematics education. This might also mark a novel opportunity for teachers, since Danish teachers are educated in general educational theory at the university colleges and only to a very small degree get acquainted with course specific educational theory. Third, the teachers were introduced to different aspects of, and ways of thinking about, the relation between science and society. This topic is challenging for students to work with and equally challenging for the teacher to convey (Sjøberg, 2005). In the program, the teachers experienced the forefront of scientific research and how it related to and impacted on society. Fourth, the program offered an overview of, and work with multiple approaches and teaching strategies, e.g., multifarious learning environments. The teachers were introduced to what Sjøberg (2005) called the three dimensions of science, namely: (i) the products of science – in the recent scientific results, (ii) the processes of science – in the presentation from the scientists on how they reached their results, and (iii) the role of science in society – in seeing that the recent result of science was applied by the society. These three dimensions were introduced explicitly with the aim that the teachers would let these dimensions play a part in the designed sequences. Fifth, the teachers were given courses in participatory action

research and multiple forms of data collection. Thus, they acquired the tools for implementing and evaluating new reconstruction sequences in their own classroom. This was the examination assignment for the second semester, i.e., a written report on how they individually had developed a sequence, and how they implemented and evaluated it on the basis of their own data collection.

In order to encourage the teachers to report and disseminate their work in the program, the teachers would have the opportunity to publish their third semester written report in a special issue of the *Series* from the Centre for Science and Mathematics Education, at the University of Southern Denmark. Further, the teacher's work on their final thesis would be presented to other teachers at a seminar.

In-house Evaluation of the Master Program

During the Science Teachers of the Future program, the Centre for Science and Mathematics Education conducted a qualitative study into the salient themes of the degree program from the perspective of the teachers. This study adhered to the basic tenets of the "naturalistic inquiry paradigm" (Lincoln & Guba, 1985; Lincoln & Guba, 2000) allowing for a study process in which categories were stipulated as embracing clusters of emergent themes. A "general inductive approach" (Bryman & Burgess, 1994; Dey, 1993) was adopted through which possible key themes could emerge and guide further subsequent studies as well as the continuous development of the degree program.

Here, we have given a brief summary of our findings of this study. After two full semesters into the degree program, the key themes emerging from the teachers' evaluations of the program involved categories, such as, *development of and reflection on practice, connectedness of their science subject(s) to others and to society, professional networking, inspiration*, and *research into own practice*; and there had been a perceivable cognitive and affective progression on the side of the teachers within the fields denoted by these themes.

One-day PARSEL Workshop

At one point during the fall semester of 2007, the participants attended a PARSEL workshop in which they were introduced to the project, and had the opportunity to discuss and comment on the project and the PARSEL model. Further, considerable time was given for them to discuss some of the PARSEL modules in groups. Each group was given two PARSEL modules to discuss and comment on. The groups were given no specific directions in terms of what they should focus on. During a subsequent plenum discussion, each group presented a critical analysis of the modules with which they had worked. The plenum discussion ended with a discussion on what the PARSEL project could mean for them in the course of their educational program. A member of the Danish PARSEL research team acted as moderator in the discussion and took notes.

In the plenum discussion, a number of critical concerns were aired. First, a majority of the groups felt that for the PARSEL modules to be inviting for Danish teachers, the layout of the modules deserved to be tuned a bit. It was suggested that even though only a small portion of the materials would be handed out to students, the parts for the teacher also needed to be aesthetically inviting, and that the mo-

dules failed to reach the standard of the newest of the contemporary Danish teaching materials on the market. This led the discussion to focus on content. In terms of content, the materials seemed to the participants to strike a tune very similar to traditional Danish teaching materials, although the participants stressed that there was a novel emphasis on the structure of the teaching strategy – the PARSEL model.

There seemed to be a consensus among the participating teachers that the modules would not in themselves stand out among the vast offers of materials for teachers, but that the modules would be excellent "stepping stones" for further development by the individual teacher. A teacher could be "inspired by the approach" to teach on the subject of, for example, soap, and then subsequently work in her own wishes of content into the material. Interestingly, the teachers arrived at a self-established notion of "ownership." Though the term ownership did not explicitly enter into the discussion, it was palpably implicit in the discussion on the benefits of having a clearinghouse of PARSEL modules.

Implementation and Evaluation Plans

As mentioned, the Danish PARSEL teachers would in total implement 10-15 modules during the fall of 2008. Rather than conducting a large scale implementation, the Danish part of the PARSEL consortium chose early on to follow closely a smaller number of teachers with this particular background.

The plans for the evaluation of the implementation followed to some extend the approach taken by the other national PARSEL teams. Thus, the evaluation of the Danish team would involve the use of both quantitative and qualitative instruments.

The main aim of the evaluation was of course the effect of the PARSEL modules regarding *relevance* and *popularity* of school science from the perspective of the students. The Danish PARSEL team, however, would also use this as a backdrop for a more narrow focus on how the Danish teachers took ownership over the PARSEL modules and used them as grounds for reflection in action research cycles. The team would do so by following closely the selection, modification, implementation, and reflection process of these teachers when they try out PARSEL modules.

Concluding Remarks

The insight gained from the pilot project "Science teachers of the future" not only aided us as researchers, but also the community of science teachers as a whole. To remember, a vital part of the educational program was the networking and dissemination part, and here we had the opportunity to involve teachers who have been persistently trained for exactly this type of operation. The involvement of the teachers with this special background would thus contribute in a strong degree to the dissemination at the national level of the PARSEL project.

Teaching has always been complex and required sustained amounts of intellectual energy. Day (2004) linked the concept of reflective practice with that of collaboration and pointed on the need of peer partnerships and networks, and periods of sustained intellectual challenge through programs of study in universities. Referring to the debate about the nature and usefulness of educational research,

Hargreaves (1999) suggested an agenda for educational knowledge creation and dissemination based on school-based initial teacher training and research. McLaughlin, Black-Hawkins, Brindley, McIntyre, and Taber (2006) presented school-university partnerships that focussed on the use and production of educational research. Two issues were crucial to the development and sustainability of the partnership, namely, the role of key individuals, and the nature and purposes of strategies for cross-partnership meetings and other activities. Through their participation in the project the teachers in cooperation with educational researchers were allowed to deepen, extend, and share their own knowledge and understanding of the content, the ways in which students build ideas, and the pedagogical implications of teaching in a manner, which encourages the teachers to design and implement learning environments that are relevant and popular to the students. The teachers got inspiration from and ownership of the PARSEL research project. In this way, the "*Science teachers of the future*" project equipped the participating teachers with experiences for acting as key individuals in networks and partnerships.

The challenge to our approach was to maintain the collaborative partnership established through the teachers' participation in the research context. According to Linn and Hsi (2000), the success of an innovation and the knowledge gained from it depend in part on being able to sustain the partnership between researchers and teachers. With the rationale of supporting teachers to participate in and contribute to the design process, there was a clear-cut need for the inclusion of instructional design in teacher education. Focus should be on the significance of teachers' cognition and practical knowledge in innovative projects, and these should be considered in relation to actual or potential classroom activities.

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