Bridging the Gap between Teaching and Research on Science Inquiry: Reflections based on Two Action Research Projects

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Abstract
Collaborative action research provides opportunities for teachers and educational researchers to develop classroom practice as a joint achievement. In this paper, we reflect upon experiences from two extensive action research projects aimed at improving the practice of science inquiry at upper secondary schools. We experienced two main challenges regarding the processes: transitioning from the planning stages to implementation, and not utilizing sufficiently the distinct voices of the teacher and the researcher to improve the practice. We argue that the concepts of tools and multi-voice from activity theory provide valuable perspectives that can complement action research strategies. We propose that the joint development of concrete tools for use in the classroom might act to bridge the gap between research and the practice of science inquiry.

Keywords: collaborative action research, teacher-researcher, upper secondary school, science inquiry, activity theory

Introduction

(...) we had an idea last year that we were to enhance scientific talk amongst the students during science inquiry. And it failed. I could not contribute enough (into our collaboration) either on theory or concrete teaching methods to facilitate students talk. [Gerd, second author, interview, 10.06.10]

This excerpt above is from a conversation between the teachers and researchers summing up two collaborative action research projects. In retrospect, it was – in spite of a common goal for change – difficult to bridge the gap between educational literature and the situated practice.
The authors were collaborating with experienced science teachers at upper secondary schools, for respectively three and two years with a common goal of improving the practices of science inquiries. The point of departure was a curriculum reform in Norway putting more weight on science inquiry (Norwegian Ministry of Education, 2006). It is well known from research literature that teachers struggle to implement inquiry (Capps & Crawford, 2012; Windschitl, 2004) and that teachers’ opinions of what it means to do science inquiry are multifaceted (Asay & Orgill, 2010). According to Groundwater-Smith and Mockler (2011) we need research taking into account the local culture of the classroom where teachers have an empowered role in developing the knowledge to facilitate change. Furthermore, Keys and Bryan (2001) suggest a research agenda for science inquiry that are centred on the teachers’ knowledge in order to produce research that bridges the gap between the practice and the research of inquiry. Thus, an approach built on collaboration between researcher and teacher aimed at developing the practice of science inquiry seemed for us to be of special value by taking account of the teacher’s situated knowledge and the researcher’s theoretical perspectives.

In the traditional form of educational action research, teachers strive to understand and to improve their practice through “action-reflection” cycles. This form takes account of the uniqueness of each educational setting and builds on the teachers’ personal professional knowledge (Elliott, 1991). Subsequently, teachers and educational researchers have turned to collaborative forms of action research as a way to meet needs for improved practice, as well as field-based research. The insider(s) and outsider(s) are supposed to contribute with their different expertise and perspectives into the project (Herr & Anderson, 2005). The two approaches of educational action research provide different opportunities as well as challenges.

The purpose of this article is to discuss how to improve the process of collaboration in order to develop the practice of science inquiry by reflecting on the possibilities and challenges from two collaborative action research projects. The article builds on two Ph.D. projects, focusing on the teacher’s role in supporting students during science inquiry (Bjønness, in progress; Johansen, 2013) as well as semi-structured interviews with the participants. The article is both theoretical and reflective. It does not present findings in the traditional sense but rather reflections and insights exemplified and illustrated using empirical material from the two projects.

In the two action research projects, we experienced the same main challenges: going from planning new teaching approaches for science inquiry to actual change in action and the lack of different perspectives and voices as a foundation to improve the practice. Turning to the literature on action research, we found little concrete support for how to facilitate the process.
However, we learned through the extensive fieldwork the importance of the joint development of tools for classroom activities that allowed for the perspectives of both the teacher and the researcher to meet.

The question driving the article is how the development of tools as a joint achievement between teachers and researchers can mediate change in practice. We argue that concrete tools for teaching science inquiry can act as an impetus for change when the development of tools are supported by educational literature as well as the situated practice. Thus, the distinguished voices of the teacher and researcher will complement each other.

**Perspectives for change in school science inquiry**

The perspectives presented here draw upon elements from the extensive research fields of: (1) science inquiry; (2) action research; and (3) activity theory.

**Science inquiry as complex practice**

There is an increased interest for inquiry based teaching following curriculum reforms all over the world (e.g., European Commission, 2007; National Research Council (NRC), 2000). However, the meanings associated with “inquiry” are multifaceted. There are two main definitions. The first definition of “inquiry” is the process that scientists use when they are conducting research along with the active learning process students engage in when they model professional scientists (Anderson, 2002). The second definition of “inquiry” refers to the activities in the classroom that facilitate the students’ learning of established science (NRC, 2000). In these action research projects, both forms of inquiries were represented.

In many ways, it is up to the individual teacher to decide or create his or her understanding and practice of what constitutes inquiry teaching (Anderson, 2002). However, literature reports on teachers’ lack of experience and knowledge on how to facilitate inquiry learning. This results in a poor learning outcome for students (Asay & Orgill, 2010). Moreover, studies on teacher’s epistemological assumptions of what it means to carry out science inquiry reveal simplistic forms of “the scientific method” (McComas, Almazroa, & Clough, 1998; Windschitl, 2004). Thus, teachers need help to form more sophisticated versions of inquiry because of tacit and culturally constructed beliefs that pervade practices, authoritative documents, classroom culture, textbooks, and media (Windschitl, 2004). Our intention was not to instruct teachers how to perform inquiry. Rather, it was to understand the situated, complex practice and develop the practice in collaboration with the teachers. It is critical to acknowledge that the local
culture of the classroom will have a significant role in the interpretation of inquiry practice (Keys & Bryan, 2001). Moreover, we became more aware of how a teacher is part of the complex practice. The teacher must juggle between the knowledge of students, the knowledge of science and pedagogy, the teaching methods and the school “code”. Thus, there are many problems and dilemmas with no clear solutions (Barnett & Hodson, 2001; Bjønness, Johansen, & Byhring, 2011).

**Action research to change school practice**

We do not intend to discuss educational action research per se; rather the intention is to bring in theory relevant to the challenges we experienced through our research projects. The main aim was to develop the situated practice of science inquiry and therefore there were not formulated explicit goals for the professional development of the teachers. This approach is close to more collaborative traditions of action research with the interest of improving a practice and contributing to the knowledge base of the relevant field (Herr & Anderson, 2005; Levin & Greenwood, 2001). However, we experienced that the process of developing the inquiry practice was empowering for both researchers and teachers (Carr & Kemmis, 2003). In the following, we will point at the two main challenges we experienced as researchers: (1) the difficulty to go from planning new practices to actual change, and (2) the lack of different perspectives and voices as a foundation to improve the practice.

In both projects, the first year of collaboration, facilitated by the researcher, followed the traditional action research spiral of iterative cycles of plan, act, observe and reflect (Elliot, 1991; Lewin, 1948). In the course of actions, we experienced that the transition between the cycles were challenging. In both practices, teacher and researcher decided to implement some changes in the following cycle but very little happened. However, we did not find that the issue of transitions was greatly problematized turning to action research literature. For example, in action research cycles, observations are the foundation for reflection. Yet there might be a danger that reflections become arbitrary because the teacher usually has limited time to observe. This also weakens the ability to scrutinize and think through the actions. Despite of much talk about reflection and reflexivity, according to Hall (1996), few accounts exist about how this is done. Further, since re-planning and new actions hinge on reflection of previous actions, it might be problematic to make good, relevant changes. If the wholeness of the situation and the underlying values are not part of the reflection, there is a danger that the action cycle is reduced to “social engineering”
(Hellesnes, 1992; Herr & Anderson, 2005). The question is what kind of resources and methods of collaboration that facilitate an actual change of classroom practice.

In educational action research, the researcher is seen as a facilitator supporting the teachers in formulating a diagnosis and an action hypothesis to be tested in their classrooms (Elliott, 1991). Thus, it represents research with people and not on or about people (Heron & Reason, 2006), although, the form of collaboration may vary during the project (Herr & Anderson, 2005). When beginning to collaborate, trust is essential (Grant, Nelson, & Mitchell, 2008) in building a relation where there is enough “sameness” so that the participants speak of the “same” (McArdle, 2008). Moreover, action research is context dependent and it is concerned about the teachers’ personal theories and values and how teachers “think-on-their feet” (Barnett & Hodson, 2001) in order to secure the students’ learning process. However, if the teachers’ perspectives are not challenged, there is a danger of reproducing the current practice (Dale, 1993). Thus, the different viewpoints provided by the teacher(s) and researcher(s) are important to preventing the researcher from developing the same “blind spots” as the teacher. So, what kind of collaborative environment can help the teacher to evaluate the context and the situations that appear? Theories can supply teachers with resources to see the contextual situations (Schön, 1983). In addition, a common language (McArdle, 2008), effort and competence for thinking with didactic concepts are important conditions for teacher collaboration (Dale, 1993) and collaboration between teachers and researchers as well.

In the action research literature, we found little concrete support about how collaboration between teachers and researchers can bridge the gap between situated practical knowledge and educational literature. However, in the literature of activity theory we found a theoretical understanding of the importance of tools and multi-voice as an impetus for change in a practice.

**Activity theory and the concepts of tools and multi-voice**

Our interest is not to make use of activity theory as a whole. Rather we borrow the concepts of tools and multi-voice, because they provide perspectives we believe are valuable to action research. Activity theory is an umbrella term for social science theories within the cultural-historical school building on the legacy of Vygotsky. Moreover, activity theory is contextual and oriented at understanding historically specific local practices, their objects, mediating artifacts and social organization (Cole & Engeström, 1993).
Tools to mediate practice

The idea of cultural mediation of actions, as formulated by Vygotsky, is central to activity theory (Cole & Engeström, 1993). The concept of mediation suggests that humans, for the most part, do not stand in direct contact with the surrounding world. Instead, we talk about the world and act in it using physical and intellectual tools that constitute integrated parts of our social practices. For instance, when using a microscope, we do not analyze the microscope as a separate entity and then study the “clean” human perceptions of the phenomenon. We must understand how thinking is performed by humans acting in social practices through artifacts (Säljö, 2001). According to Engeström (1999), artifacts include both tools and signs and, for the sake of simplicity, we will focus this article solely on tools as artifacts.

Mediation through tools is, according to Vygotsky (1978), both outwardly and inwardly oriented. Both aspects are present in every cultural tool (Cole & Engeström, 1993). For instance, when teachers introduce a practical supporting tool, e.g. IMRaD (introduction, method, results and discussion) for writing reports to the students, the tool has a bidirectional effect. It simultaneously mediates the activity of writing the report and modifies the students’ concept of what it means to perform science.

Engeström (1999) underlines the necessity to differentiate between different ways of using tools by suggesting four types:

- **How** tools are used to guide and direct processes and procedures (e.g., meta-talk used to guide and constrain a discussion).
- **What** tools are used to identify and describe objects (e.g., theoretical concepts and concepts appropriated for practical use).
- **Why** tools are used to diagnose and explain the properties and behaviour of a practice. They can be used to reach a decision (e.g., the why question).
- **Where to** tools envision the future state or potential developments of a practice (e.g., explicate and examine collectively the solutions).

As there are different ways of using tools, there is nothing fixed in a tool that would determine that it could only be, for instance, a “why” tool (ibid.). A conceptual model may typically function as a dynamic diagnostic tool (why tool) but it may also be a frozen definition used only as a “what” tool to identify and classify phenomena.
**Multivoicedness as an aspect of collaboration**

We find that the aspects of collaboration in action research theory largely are focused on trust (Grant et al., 2008), sameness (McArdle, 2008) and reciprocity (Robertson, 2000) between the practitioner and the outsider. Moreover, power relations between the participants are seen as a part of the collaboration (Herr & Anderson, 2005). Power is regarded as inherent in every relation being both constructive as well as restrictive (Flyvbjerg, 2001). In collaboration between teacher(s) and researcher(s), the power relation will for instance dependent upon who has the authority to make decisions regarding different aspects of the action research project. However, the role of different perspectives and voices in changing a practice is perhaps less communicated in action research.

In activity theory, the tool-mediated construction of an action does not happen in a solitary manner or in harmonious unison. It is a collaborative and dialogic process in which different perspectives (Holland & Reeves, 1996) and voices (Engeström, 1995) meet, collide and merge. Engeström (1987) put emphasis on the crucial role of goal/problem construction in innovative learning. The initial existence of a shared problem cannot be taken for granted in work teams. Moreover, the formation of shared goal is a major collaborative achievement. When working together and developing a practice, there will always be different views related to one’s interests, traditions and position. This is what Engeström calls multivoicedness: “It (multivoicedness) is a source of trouble and a source of innovation, demanding actions of translation and negotiation.” (Engeström, 2001: 136). The term originated from Bakthin, and says something about how we deal with different viewpoints, by understanding that participants will have different perspectives and see this as a possibility for growth as well as a challenge. In developing a practice together, the teacher and researcher may not always agree on what they are going to achieve – and how to do it. This can be seen as at least two problems, first, the problem of not necessarily wanting the same outcome because of the different positions. Second, when developing a complex practice, the object (what one wants the result to be) can never be precise. It is, as Engeström so nicely put it, a moving target (Engeström, 2001).

**Methods and context of practice**

**Methods**

Two action research projects provide all the examples in this paper. In both projects we strived for trust and reciprocity. We practiced a division of labour where the teacher was responsible for the implementations in the classroom and the researcher for documenting the
research process. Moreover, the teacher and researcher were planning and reflecting over the learning activities together, as well as formulating a common aim for the development of the inquiry practice. The researchers gathered empirical material at each school over two and three years respectively. The material included: video and audio recordings from the field work, students’ products and teachers’ handouts, reflection-notes, and conversations with the participants. This provided us with a rich empirical material. Moreover, as researchers in a complex practice, some of our after-field reflections are not directly emerging from our data material. Participating in the practices generates tacit insights and the researcher should not simply rely on the documented sources of the empirical material (Hammersley & Atkinson, 2007).

As part of our reflection and evaluation after the completion of the fieldwork, we conducted a semi-structured group interview (4 hours) with the teachers. In the interview, the teachers, Ellen and Amir, each made a summary of the action research and its impact on their classrooms. Then, the teachers and researchers talked together about the possibilities and constraints experienced during collaboration to improve practice. The interview was transcribed and in the transcription process some features such as tone of voice and pauses are lost, whereas others are gained (e.g., punctuation) (Kvale, 1996). However, the authors do not regard the interview as the blueprint of the participants’ meanings or ideas. The interview, as well as the rest of the empirical material, are not statements directly representing the practice and research, but rather seen as a re-representation of what was perceived as salient at the time (Van Leeuwen, 2008). We present some part of the material that we believe is useful to explicate the ideas and understandings we have today.

**Context of the two action research practices**

Although we worked with teachers at two different schools with different approaches to science inquiry, there were similarities. The two upper secondary schools are both located in suburban areas outside the capital of Norway. In general, the groups of students were not very motivated with regard to the schoolwork or science. In addition, the teachers described some of the students as reluctant readers and writers.

**Dale upper secondary school**

The first author, Birgitte, worked together with an experienced science teacher named Amir for three action cycles to develop a twelve-week open inquiry science project. Other science
teachers were also involved in the project in the first and second year but, because of different reasons, they did not continue into the third year. The collaboration consisted of meetings to plan the students’ inquiry projects, ad-hoc meetings during the course of action, and evaluation after each cycle. The common goal was to develop a practice of open inquiry. This form of inquiry is often described in literature as a means to enhance more authentic science inquiry (e.g., Duschl & Grandy, 2008) and promote active, autonomous learning (e.g., Hodson, 2009). The students identify problems and ask questions, design and plan investigations, collect and analyze data, create explanations and reach conclusions, and then report their findings. Amir's main intention with the project was to increase his students’ motivation for learning, understanding of the subject and grow their feeling of success concerning science.

**Hill upper secondary school**

The second author, Gerd, worked together with Ellen for two years in order to develop and improve structured inquiry practices, a more common form of inquiry in schools in which teachers determine the questions and specific procedures of the investigation (Asay & Orgill, 2010; Crawford, 2007). The aims of these inquiries were knowledge and understanding of scientific ideas and content in addition to procedural understanding. Ellen is a very experienced science teacher and she believes it is important to develop her own teaching practice. Ellen and Gerd had a special focus on how the use of multiple semiotic resources (e.g., visual images, tables and concrete objects) can support students’ learning from science inquiries. To Ellen, it was important that the students in the class perceived science as manageable and that she, as teacher, could facilitate the subject matter so that the students mastered it.

**The two practices: Tools and multi-voice**

We do not intend the episodes from the two action-research projects presented here to represent exemplary instances in the development of the practices. Rather, they show some of the possibilities and constraints experienced in the collaboration between the teacher and researcher in a complex practice. We will present four snapshots from our practices to address the aim of this article and complement them with quotes from interviews to discuss how the development of tools, as a joint achievement between teacher and researcher, can mediate change in practice. We provide examples from two practices – Hill and Dale – for the tool and multi-voice concepts. We structure the snapshots by first introducing a problem concerning school science inquiry experienced by both practices. Next, we present a snapshot from the practices and
include quotations from interviews. Finally, we put forward a short interpretation and discussion of the situation.

Developing tools for improving the practice of science inquiry

In both practices, we recorded little scientific dialogue neither in whole-class discussions nor in the individual science-inquiry student groups. These are well known problems from the literature of science education (Bennett, Hogarth, Lubben, Campbell, & Robinson, 2010; Driver, Newton, & Osborne, 2000). The first case exemplifies how lack of concrete tools may have prevented development of the students’ inquiries while the second case shows the possibilities found in the joint development of a tool for the practice.

**Hill case – first example**

When Gerd started to work together with Ellen, she observed there was little talk between the students (age 16) concerning science. Because Gerd had read Vygotsky (1978) and was also very inspired by Mortimer and Scott (2003), she saw these theoretical perspectives as a salient approach to improve the small and structured inquiries. She proposed to Ellen to increase emphasis on the students’ collaborative talk but it rather fizzled out and did not come to fruition. Using the example of ethical discussions as part of school science, Ellen said:

“*They (the students) have to go into this – the students have to learn this… We (teachers) are so concerned with subject matter (the canon of science). This, I believe, is because we do not dare to go into other ways of discussing.*”

Ellen’s statement corresponds to findings by Oulton et al. (2004) claiming that few science teachers are prepared and know how to engage students in open discussions. Problems have also been reported about engaging students in collaborative talk about the subject matter (Bennett et al., 2010). This example illustrates how difficult it is to change the practice. However, we believe it is important that the researcher supports the teacher in dealing with what perhaps is a slightly scary new practice. Even if the teacher agreed in principle to the goal of “more scientific talk”, in practice, it was problematic to carry it out. Furthermore, emotional support from a researcher is not enough when the teacher faces students who are reluctant to learn and where the teacher has little room to take risks. The teacher and researcher had not created comprehensive and useful tools for engaging students in collaborative talk and open discussions of science.

In order to discuss the role of tools (Cole & Engeström, 1993) in developing a practice we can start by envisioning what Gerd and Ellen could have done in the situation. First, together they could have used a “what tool” to identify and describe the problem with the existing
practice. Relevant theoretical perspectives relating to talk in the classroom could have illuminated different approaches. This would perhaps require that the teacher read more literature of science education. However, in a world running on “teacher-time” this is difficult to do. Another possibility is that the researcher presented some perspectives, while the teacher and researcher discussed consequences and jointly developed “how tools” to guide and direct the students’ learning processes. For example, how the teacher could structure the students’ tasks to help them sort scientific claims. Following the implementation of a “how tool”, the researcher and teacher could have used a “why tool” to diagnose and explain how the new practice worked in relation to the purpose. In addition, a “where to tool” could envision the future state or potential development. In the next case, we will provide an example from Dale upper secondary school to illustrate the advantage joint development tools to improve the situated practice.

Dale case – second example

In the case where Amir and his colleagues wanted to develop an open inquiry project, the teachers and the researcher made a diagnosis of the possibilities and the constraints in the project after the first year of collaboration. Birgitte then wrote a discussion paper supposed to represent a meeting point between the teachers’ reflections on how the design worked out in the classrooms and the researcher’s theoretical knowledge. The researcher pointed out critical issues concerning the students’ inquiries that were characterized by trying and failing and little scientific talk among the students. In order to scaffold the students’ scientific talk, Birgitte made a suggestion for a tool inspired by how Amir let his students present their work to each other during the inquiry process. The tool was named “research meeting” and it was implemented in critical phases of the inquiry to facilitate the students’ support and challenge of each other’s’ work. Birgitte suggested that she could carry out the “research meetings” and Amir agreed with her. In the following quote, Amir revealed his opinion concerning the value of developing tools together:

“… you (Birgitte) show many initiatives that I don’t have to controvert because I see, when you bring in that initiative, that you have a good understanding of what we can expect from each other. For example the concept of ‘research meeting’, then we have a clever idea, and you have been given the possibility to practice it and see how it works, and I have learned from it without doubt. I have many positive opinions about that.”

The example illustrates the significance of developing tools as an impetus for change in practice. The utterance also reveals the importance of trust between the teacher and the researcher (Grant et al., 2008). Furthermore, the “research meeting” had evolved from an existing practice
developed by the teacher into a joint effort. The teacher had tacit understandings of what “works” and the researcher developed the tool further by using theory of cooperative learning (Johnson & Johnson, 1990). The implementation of the “research meeting” created an opportunity for Amir and Birgitte to reflect-on-action, to study students’ dialogues, and to observe if the tool facilitated the students’ scientific talk. The snapshot reveals the use of several types of tools. The “research meeting” serves as a “how tool” in respect to facilitating scientific talk amongst the students. It can also be seen as a “what tool” in the way it actually represents an important feature of science inquiry. The “discussion paper”, written after the first cycle of the action research can be seen as a tool itself. It represents both a “why tool” used to diagnose the open inquiry project and a “where to tool” envisioning the potential development of the project. However, the only substantial change in practice during the following cycle was the “research meeting” despite several other suggestions for improvements raised in the “discussion paper”. Thus, it can be questioned whether the “discussion paper” actually represented the teachers’ voice sufficiently for them to find it meaningful. This brings us to the role of multi-voice in changing a practice.

**Challenges and possibilities of multi-voice for changing practice of science inquiry**

When working together to develop a practice, there will always be different point of views relating to ones interests, traditions and position. This is what Engeström (2001) calls *multivoicedness*. Two snapshots from each of the action research projects illustrate challenges and possibilities with multi-voice. The point of departure is a well-known problem related to science inquiry in school, namely the gap between the domain of observables and the domain of ideas during science inquiry (Tiberghien, Veillard, Le Maréchal, Buty, & Millar, 2001), more commonly called the problem of “hands-on – mind-off”. In a study of the effectiveness of practical work, Abrahams and Millar (2008) found that the teachers very often separated between teaching scientific knowledge and procedures of science inquiry. However, teachers strive to find good solutions to deal with these challenges (e.g., Hodson, 2009). The first example shows how lack of multi-voice may prevent change in practice and the second example illustrates the possibilities given by multi-voice.

**Dale case - third example**

Field observations and the students’ written reports from the first year of action research revealed many “hands-on” activities with less focus on the “mind-on” part of science inquiry.
Amir and Birgitte did not agree on how to handle the problem. The following quote reveals Amir’s espoused beliefs concerning the group of students with low interest and achievement in science and the role of theory in their inquiry projects.

“… you know, the expectation that they should be able to connect a proper theory, in a professional way, I believe it’s unrealistic (…). I think they (the students) need more maturity to be able to bring in the correct theory to describe what they do. Imagine you are in that age and (...) you don’t read science and the only communication you have with science is what you learned at school. Suddenly you are expected to bring in theory that explains what you are doing, in my opinion it is a very professional expectation and it’s difficult to get them to (do that)”

The example illustrates the implicit disagreement between the teacher and researcher concerning the value of bringing in more theory in the students’ inquiry projects. The historicity of the situated practice explains this. Amir discovered that the current practice – focusing mainly on the experimental part of science inquiry – motivates these students and, thus, he was reluctant to change. The teacher’s main goals with the inquiry project were indeed to motivate the students and to give them feeling of mastery in science. Thus, Amir was reluctant when Birgitte suggested having an explicit focus on how to help students bring in relevant theory to inform their inquiries. In this example, the researcher and teacher did not manage to resolve their disagreement and take advantage of the possibilities multi-voice could represent in the collaboration. In the course of action, Birgitte understood how important it was for Amir to have an ownership to the suggested changes. Thus, a possible solution in this case could have been to provide Amir with relevant research literature knowing his interest in reading literature about science and education. Relevant literature could then represent another voice. The next example from Hill upper secondary school illustrates how multi-voice was an important element of improving a practice.

**Hill case – fourth example**

During the second year of Ellen’s and Gerd’s collaboration, they planned lessons together and tried to find good resources (“how tools”) that might support students' meaning-making of structured science inquiries. Ellen described the collaboration:

“We think together. That I perceive as working well, because the thoughts often become very unsystematic, but to have someone to think together with on a common project then it becomes more systematic.”
From a reflective position, this “thinking-together” has two important features. First, the teacher and researcher exchange ideas about apt resources connected to the structured inquiries. The resources are discussed and scrutinized for what they can offer to students’ meaning-making (e.g., Ogborn et al., 2004). A common goal exists but the situation allows for multi-voice: views are explicated and argued for, yet agreement is not required. Vital in this multi-voice collaboration was to bring in other voices for instance textbooks or internet sites. To make a critique of a “third party” is perhaps easier than to make a critique of each other’s position and made it possible to practice “why tools”. Moreover, the teacher has veto concerning what he/she implements in the classroom. This means that the teacher is the chief judge about what to do. Second, through “thinking together” – letting different voices contribute – it was easier to make concrete tools for implementation, as long as the teacher had the final decision for how to implement the tools.

Some final reflections

In this article, we set out to discuss how teachers and researchers can bridge the gap between educational research and teaching. Our position is not to seek a total overlap between these two domains. Instead, it is to ensure that the research domain aids in the development of teaching practices and that the situated teaching provides important perspectives into educational research. However, teachers rarely get the time to see the whole picture of their practice and many live isolated from research findings and theoretical debates about key issues of science education (Hodson & Bencze, 1998): As a consequence they often reproduce their own practice. Further, Hodson and Bencze (1998: 692) state:

“Because teachers’ views are built up over a long period and are burnished in the furnace of everyday practice, challenges must be vigorous and explicit if change is to occur”.

Through the authors’ experiences during the two action research projects and reflection afterwards, we suggest that the concepts of multi-voice and tools are useful supplements to a collaborative action research approach. We advocate that multi-voice and tools provide an opportunity to challenge an established practice.

There is a gap between teacher and researcher in action research due to different roles, positions and focus (Herr & Anderson, 2005) thus what Engeström (2001) calls multi-voice. In our opinion, the teachers and researchers must be explicit about their positions throughout the entire collaboration. The researcher and teacher can open up and explicate their different positions, as in the case of Ellen and Gerd, where they challenged each other in their
understanding of “good resources for learning”. The concept of multi-voice provides an understanding of teachers and researchers’ different point of views as a force for developing a practice. Further, the concept of multi-voice raises the awareness of relevant theory as a significant voice itself and contributes to the aim of collaboration.

Literature on action research stresses the importance of trust (Grant et al., 2008) and sameness (McArdle, 2008) in the relationship between teacher and researcher. Trust is perhaps especially important in research on educational practices as the practice of teaching is closely connected to the teacher as person (Barnett & Hodson, 2001). Thus, if there is little trust and sameness in the relationship between teacher and researcher, multi-voice might be experienced as threatening. This calls for, in our opinion, a considerate balance between trust, sameness and multi-voice in the process of developing a practice. Challenges that are too profound may lead to withdrawal and, on the other hand, small challenges may lead to little development of the practice. Low or implicit challenge was perhaps the case in the collaboration between Birgitte and Amir on strengthening students’ use of theoretical input in their science inquiry (example 3). However, perhaps both Birgitte and Amir had explicated and argued sufficiently for each of their positions and the matter was not resolved according to the researcher’s ideas because Amir based his decision primarily upon his situated knowledge. This reveals another problem when working together developing a practice: who is going to decide what? A teacher must perceive that the change in practice will be both manageable to carry out and beneficial for the students. If not, the teacher will continue the existing practice. In classrooms where most of the students are reluctant learners, as in the present cases, there is a tendency for the teachers to concentrate their teaching on repeating facts and rote learning (Hodgson, Rønning, Skogvold, & Tomlinson, 2010; Yerrick, Liuzzo, & Brutt-Griffler, 2012). In such situations, there is perhaps a special need for negotiations between the teacher and researcher that are based on the situated classroom practice. In this case, the authors propose that joint development of concrete tools to mediate the change in classroom activities could have overcome the teacher’s resistance to change and explicate the researcher’s intentions.

There will always be a gap between teaching and educational research. The research provides perspectives to understand education in general and, in our cases, science inquiry in particular while teaching provides perspectives on the situated practice. However, the teacher might not have experienced educational literature as relevant; it has little to contribute to his or her particular practice. Moreover, perhaps, research is too often prescriptive in the sense that it gives teachers long lists of “you ought to do”. To avoid patronizing the teachers’ practice, the
authors experienced that working together to design tools to be used in the classroom (how tools) proved to be a driving force for sustainable change. In addition, the process of translation and negotiation between teacher(s) and researcher(s) can be seen as a possibility for personal growth.

Reciprocity, trust and multi-voice were part of the relationship that made it possible to make “how tools” mediating the actual classroom activities. The teachers found the development of “how tools” useful within their working frames with limited time. The other types of tools described by Engeström (1999) – why tool, what tool and where to tool – are important to providing support for reflections outside the classroom activities and to direct further development. The shape and the use of these reflective tools outside the classroom have direct influence on the relationship between the teacher and the researcher ensuring trust and multi-voice. The tool changes the users as well as the activity upon which it mediates (Cole & Engeström, 1993). The point is that a tool, in addition to influencing an activity, also has an effect on the teacher using it because he or she will look differently on their own practice – and perhaps see new possibilities. This was the case when Ellen and Gerd developed tools, such as pictures and illustrations, to increase students learning from science inquiry. Concerning the use of illustrations in her teaching, this collaborative work increased Ellen’s general consciousness on resources for teaching and learning.

We argue that tools are in-between theory and practice: uniting a situated understanding and educational theory. Thus, tools might act to bridge the gap between research and practice. The teacher has to be able to use the tools in the rough and tumble of the science inquiry – not to fall back on previous practice. The tools applied as a change-agent in the classroom need therefor to be concrete, robust, made and re-made to fit the situated practice. If users consider the tool to be between theory and practice then the development of the tool needs to draw from the situated practice and the tool’s theoretical foundation. However, herein lays one of the problems when transferring a tool from one situation to another. The tool “research meeting” as described in the second example draws on two theoretical positions: (1) socio-cultural perspectives of oral language as a vehicle for students’ understanding of the inquiry process and results and (2) peer-review processes in “professional” science to assess and argue for methods and results. Thus, the “research meeting” has epistemological underpinnings connected to the production of science and to learning science. The tool made in one situated classroom practice, will be changed when it meets another practice. Sannino and Nocon (2008) emphasize that sustainability of innovations does not only refer to local continuity but also to diffusion and
adoptions in other settings. This generates a problem: how to convey the epistemological foundations for the tool; they might be lost and all that remains is the “shell” of the tool. From our position, one must emphasize robustness when developing a tool to ground it in epistemology. However, the teacher will adapt the tool into his or her situated practice, and we firmly support Ellen’s statement:

If I get ready-made things (tools), then I think it’s a bit difficult to use them, but tools where you are sitting together in a creative process – then I make them my own. [Ellen, post-interview, 10.06.10]

References


