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### Connecting practice-based research and school development. Cross-professional collaboration in secondary education

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# CHAPTER 3

## Boundary crossing in R&D projects in schools: learning through cross-professionals collaboration<sup>1</sup>

3

### Abstract

School leaders, teachers, and researchers are increasingly involved in collaborative research and development (R&D) projects in schools, which encourage crossing boundaries between the school field and the research field. It is not clear, however, what and how professionals in these projects learn through cross-professional collaboration. The aim of our study is to create a better understanding of the learning of boundary crossers who are involved in cross-professional collaboration in R&D projects. In this multi-case study we analyzed data from interviews with school leaders, teachers, and researchers of nineteen R&D projects in Dutch secondary schools. We interpreted boundary crossers' learning in terms of learning mechanisms (*identification, reflection, coordination, transformation*) and related these learning mechanisms to different types of cross-professional collaboration. Three combinations of learning mechanisms were prevalent: *identification* and *coordination*, *reflection* and *transformation*, and *transformation* for school leaders, teachers, and researchers. Different types of collaboration seemed to evoke different learning mechanisms. Boundary crossers in R&D projects learn from the other professionals' tools and objects and may expand their professional ways of working. *Transformation* for all participants, in particular, is related to school- and researcher-directed collaboration. In this type of cross-professional collaboration, most school leaders and teachers developed a research attitude by having a critical and reflective stance towards school interventions, and researchers developed a practice engaged research approach by being aware of the complexities of school practice.

**Keywords:** Boundary crossing; cross-professional collaboration; learning mechanisms; teacher researcher; cultural historical activity theory; R&D projects

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<sup>1</sup> This chapter is based on Schenke, W., van Driel, J.H., Geijssel, F.P., & Volman, M.L.L. (in revision). Boundary crossing in R&D projects in schools: learning through cross-professional collaboration.

## Introduction

School practitioners and researchers, advisers, and supervisors are increasingly involved in research and development (R&D) projects in education in the United States, United Kingdom and elsewhere in Europe, for instance in the Netherlands (Coburn & Stein, 2010; NTRP, 2012; Onderwijsraad, 2011; Rust, 2009). R&D projects encourage professionals to engage in practice-based research that aims to contribute to school development, i.e. activities undertaken with the intention to improve practice, and to generate new knowledge. R&D projects facilitate cross-professional collaboration, which is described in this study as a process in which a diversity of professionals come together with divergent reasons to reach project goals. They attempt to reach project goals by guiding, directing and performing research and development activities, and through mutual communication (Penuel, Fishman, Cheng, & Sabelli, 2011; Van de Ven, 2007; Wagner, 1997). As the school practitioners and external educational experts collaborate in the project they have the possibility to learn from each other's backgrounds and perspectives on school field and academic research field. However, little is known about the learning of school practitioners and external educational experts as they collaborate in an R&D project. Furthermore, whether and how learning results in changes in the practices of both parties, is also unknown (Max, 2010; Vanderlinde & Van Braak, 2010).

School practitioners and researchers, advisers, and supervisors, who usually belong to different fields, interact in R&D projects, while traditionally these fields have their own rules and communities and are even seen as being separated by a gap (Broekkamp & Van Hout-Wolters, 2007; Engeström, 2001). A promising concept to investigate the learning of professionals in R&D projects is boundary crossing (Hora & Miller, 2011; Taylor, 2008; Tsui & Law, 2007). Practitioners can cross boundaries to the field of researchers by being engaged in a study. This is notable, for example, in collaborative action research of teacher researchers. As they conduct research activities in schools they might use terminology and tools that are derived from the academic field (Lytle & Cochran-Smith, 1990; Leeman & Wardekker, 2014; Rust, 2009). Researchers are crossing boundaries when they engage in a study that requires them to focus on questions raised in school practice. As they become involved in practical activities in school, they might use terminology and tools of the school practitioners (Coburn & Stein, 2010; Geijsel, Krüger, & Slegers, 2010; Grundy, 1998).

In studies on collaboration between school practitioners and researchers, advisers, and supervisors the issue of learning of those who collaborate has remained largely unnoticed. Instead, the research and development activities

and results of these activities are usually focused upon. The aim of our study is to create a better understanding of the learning of boundary crossers who are involved in cross-professional collaboration in such R&D projects. Awareness of the complexities and opportunities that such learning entails, may contribute to better collaboration between practitioners and researchers, advisers, and supervisors in the future.

### **Boundary crossing in R&D projects**

In order to understand boundary crossing by school practitioners and researchers, advisers, and supervisors in R&D projects it is helpful to characterize the different worlds of these professionals as activity systems. In line with cultural historical activity theory (CHAT) we identify schools and research institutes as activity systems that include community members who work with their own tools and objects (Engeström, 2001; Wenger, 1998). According to CHAT, members of the same activity system share motives. Their objects are seen as purposes of the activity system and they use several tools to achieve these purposes. Teachers have the object to provide good education and their primary motive can be indicated as support for students to grow up as full members of society. They do so by providing students the conditions to learn, by developing pedagogical approaches, by giving and evaluating lessons, by mentoring students, and by monitoring students' progress. School leaders' objects are in general to assure good education, by providing the right conditions for teachers and students for learning. The motive of school leaders is broadly comparable to the one of the teachers, because they are members of the same activity system. The motive of educational researchers to perform research is knowledge development but their object can be more oriented to contributing to school practice or to contributing to academic knowledge. Researchers' tools are for example questionnaires and literature studies. Educational advisers and supervisors are usually seen as intermediaries between school field and academic research field who have the purpose to translate research knowledge to school practice and who are critical friends to school practitioners. Contributing to educational change is seen as the primary motive of advisers and supervisors (Akkerman, Bronkhorst, & Zitter, 2013; Cornelissen, Van Swet, Beijgaard, & Bergen, 2011). Advisers and supervisors function between the activity system of school field and research field. In this sense advisers and supervisors have their own activity system with their own tools, objects and motives, placed next to the activity systems of school field and research field (Engeström, 2001; Swaffield, 2004; Vanderlinde & Van Braak, 2010). Traditionally, researchers, advisers, and supervisors and school practitioners do not meet each other very often. Researchers, advisers, and supervisors work at universities or other research or advisory institutes, while practitioners work at

schools. For this reason, their primary work takes place with a physical distance. Teachers regularly perceive academic researchers as 'out of touch', while researchers might say teachers are not interested in research results (Broekkamp & Van Hout-Wolters, 2007; Gore & Gitlin, 2004).

Boundaries exist between activity systems. Boundaries can be seen as social constructs of barriers to keep others outside an activity system, and at the same time motivates insiders to remain members of the activity system (Edwards, Lunt, & Stamou, 2010; Wenger, 1998). In the cases in which boundaries between activity systems are crossed, these professionals are referred to as "cultural brokers who can walk between worlds and translate the cultural models of one group for another" (Hora & Miller, 2011, p. 92-3). Walking between worlds, or crossing boundaries between activity systems, makes professionals aware of new tools and objects and offers them the opportunity to use these tools and pursue these objects. We define boundary crossing of professionals in R&D projects as a process in which they become aware of (new) tools and objects that are common in other activity systems and as a result have the opportunity to expand their professional ways of working (Hora & Miller, 2011; McLaughlin & Black-Hawkins, 2007; Roth & Lee, 2007; Taylor, 2008).

Earlier studies on boundary crossing concentrated on persons who cross boundaries from an activity system to another in the course of time, for example from a training situation to work (Akkerman & Bakker, 2011; Engeström, Engeström, & Kärkkäinen, 1995; Max, 2010). The perspective of boundary crossing has not yet been used to study R&D projects in education, which are characterized by cross-professional collaboration between researchers, advisers, and supervisors and school practitioners. Studies on such cross-professional collaboration in turn are usually anecdotic and based on reflections on experiences with R&D projects (Coburn & Stein, 2010; Penuel et al., 2011). We aim to study boundary crossing in the context of R&D projects in a more large-scale and systematic way, focusing on learning by boundary crossers.

## Learning mechanisms

Based on a review of 181 studies on boundary crossing, Akkerman and Bakker (2011) distinguish four learning mechanisms that characterize the learning processes of professionals who cross boundaries between activity systems. We will provide a short description of these learning mechanisms, applied to professionals working in education:

- *Identification*: This learning mechanism entails at first the *identification* of the different perspectives of school field and research field. In fact, the boundaries between the different worlds come to the front and professionals create a better

understanding of the position of oneself and the boundaries of the activity system one is part of (Edwards, Lunt, & Stamou, 2010; Roth & Lee, 2007; Tsui & Law, 2007). Ultimately, *identification* results in legitimating coexistence (Akkerman & Bakker, 2011).

- *Coordination*: In this case professionals overcome the boundaries of two or more activity systems, which leads to effortless movement between different practices, while the characteristics of the activity systems are not changed. *Coordination* can be associated with role transition (Ashforth, Kreiner, & Fugate, 2000) by which boundary crossers put their original role to the background, at least temporarily. As experiences with this new role increases, the less difficult the role transition will be in future situations; this is called routinization (Akkerman & Bakker, 2011).
- *Reflection*: Professionals can also *reflect* on their own role and that of others. By ‘making and taking perspective’, they are able to obtain a new understanding of others’ and their own activity systems. It also leads to an expanded set of perspectives originally belonging to others, which is used by these professionals in new situations they come across (Akkerman & Bakker, 2011; Bronkhorst, Meijer, Koster, Akkerman, & Vermunt, 2013).
- *Transformation*: This learning mechanism entails confrontation with boundaries of the existing activity systems, for example because problems cannot be solved with the original tools belonging to the professionals. They will apply new tools and objects of the other activity system(s), which leads to *transformative* changes in the professional activities of the professionals themselves as well as changes in their own activity system. This process can also potentially lead to a new in-between practice, in which tools and motives are collectively shared between the professionals (Star, 2010, p. 602), which is also known as a boundary practice where elements from both activity systems are present and boundary crossers show efforts to proceed with joint work (Akkerman & Bakker, 2011; Tsui & Law, 2007).

The learning mechanisms might be a useful framework to characterize learning of school practitioners and researchers, advisers, and supervisors in R&D projects. Each learning mechanism might provide specific opportunities to at least become more aware of their professional ways of working as they come in close contact with tools and objects that belong to the other activity system. So, each learning mechanism can involve individual changes of the school practitioners and researchers, advisers, and supervisors in the way in which they perceive and enact their original role. Individual learning might also resonate in the way the professionals in an R&D project collaborate.

Cross-professional collaboration among school leaders, teachers, researchers, advisers and supervisors in R&D projects has been examined in an earlier study (Schenke, Van Driel, Geijsel, Sligte, & Volman, in press). In this study the characteristics of cross-professional collaboration in R&D projects were analyzed by focusing on three dimensions: reasons for collaboration (with ‘congruent reasons’ meaning similar goals and motives of practitioners and researchers, advisers, and supervisors for the project; and ‘additional reasons’ meaning that researchers, advisers, and supervisors also have their own research-related goals that are not necessarily relevant for the school), division of roles and tasks (who directs and guides the research? are teacher researchers involved in the project?) and communication structure (how is communication organized? How much time is invested in meetings?). Based on differences on the three dimensions, we made a distinction between four types of cross-professional collaboration (Schenke et al., in press).

- School-directed collaboration: in this type of collaboration teachers and school leaders are responsible for performing practice-based research in their school, whereas researchers and supervisors are seen as critical friends.
- School- and researcher-directed collaboration: teachers and school leaders are responsible for performing practice-based research in their school, whereas researchers, advisers, and supervisors are seen as sparring partners who provide support on decisions to be made on the research and on school matters.
- School- and adviser-directed collaboration: researchers and advisers are in control in this type of collaboration. They are concentrated on achieving the project goals as set by the school board. Often there is a steering group in which school leaders take part.
- Researcher-directed collaboration: researchers have additional interests next to the questions a school has raised. School practitioners have a minor role in the practice-based research.

A main difference between the four types of collaboration is the extent to which the school or an external party directs and guides the project (Schenke et al., in press). In addition to the learning of individual professionals in R&D projects, we are interested in relationships between learning mechanisms that occur in these projects and the type of cross-professional collaboration that is characteristic for the project.

## **Research questions**

The aim of our study is to create a better understanding of learning of boundary crossers who are involved in cross-professional collaboration in R&D projects in

secondary education. For this purpose, we will use the four learning mechanisms that were proposed by Akkerman and Bakker (2011) to characterize the learning processes of educational practitioners and researchers in such collaborations: *identification, coordination, reflection* and *transformation*. The research questions we address are: (1) Which learning mechanisms are characteristic for boundary crossers in collaborative R&D projects?, (2) How are types of cross-professional collaboration and learning mechanisms of boundary crossers related?

## Method

### The case studies

This study is set up according to a multi-case study design (Yin, 2009). The cases were nineteen R&D projects in secondary schools in the Netherlands. Five cases were studied more in-depth. The projects received funding from the Dutch Council for Secondary Education for research purposes for one, two or three years after the funding application was accepted. This study covers the first two years of the projects. The funding scheme was intended for carrying out practice-based research that examined questions and problems experienced in schools. For example, the use of digital material designed by teachers was evaluated, an instrument for measuring literacy skills was developed, teachers trained their pedagogical skills and changes in the classroom were observed. Only schools could apply for funding but they were supposed to (partly) transfer the research budget to an external party with research expertise: researchers, advisers, and supervisors from universities, universities of applied sciences, teacher education institutes, and research and advice bureaus.

### Participants in the study

In the collaborative R&D projects in schools, school practitioners and researchers, advisers, and supervisors were involved. Participants in this study were school leaders, teachers, and researchers. We decided not to include in this study professionals who identify their primary role as adviser and supervisor. The main reason is that their boundary crossing is from a different order than boundary crossing by school leaders, teachers, and researchers. In fact, it is inherent in their role as adviser and supervisor, or in other words: cross-professional collaboration is in the core of their professional identity. Their learning is a differential one and lies therefore out of the scope of our study. In the discussion this will be further elaborated on.

In three rounds of interviews, we interviewed in total twenty-eight school leaders and teachers who functioned as project manager in their schools, and twenty-three researchers from educational institutes. In most schools, project managers and researchers remained the same from round to round, but in one school we interviewed another project manager in round two and three. In three projects other researchers got involved during the process, therefore more than nineteen researchers were interviewed. Extra information on the role of teacher researchers in the projects was acquired by interviewing nine teacher researchers who collected and analyzed data in their school.

### **Data collection**

Data were collected in three rounds of interviews; at the beginning (round 1) and end of the first year (round 2) of the R&D projects and at the end of the second year of the projects (round 3). The participants in each project were interviewed individually, in order to have an in-depth conversation with every individual on their perception of boundary crossing in the project in which they participated. All interviews with the school leaders, teachers and researchers in the projects were based on pre-structured interview guidelines. These interview guidelines contained questions about the purpose of the R&D project, the progress made in the project, cross-professional collaboration among the professionals in the projects, boundary crossing, and learning of professionals. Additional documentation was also collected, i.e. project applications, progress reports by project managers, and reports of meetings in which experiences were shared between professionals of different projects. The purpose of collecting these documents was to use them in the preparation of the interviews as well as in the analysis of the interviews as background information.

### **Data analysis**

The first phase in the data analysis involved the construction of a pre-prepared coding scheme (see Appendix A). An important component of the coding schemes were the indicators we described for professionals in R&D projects, firstly to identify them as school leader, teacher, or researcher by concentrating on their primary roles and tasks, and secondly to recognize them as boundary crossers. The indicators we used for recognizing boundary crossers were extracted from the definition of boundary crossing as mentioned earlier. In this definition tools and objects of the specific activity systems were essential elements. School leaders and teachers were characterized as boundary crossers when they engaged in research activities to create knowledge (originally an object of researchers). Their tools might range e.g. from completing a questionnaire to designing questionnaires.

Researchers were characterized as boundary crossers when they engaged in research that required them to focus on questions raised in school practice (originally seen as an object of school leaders and teachers). An object of school leaders these researchers might adopt is assuring the right conditions for students for learning. None of the researchers in these R&D projects were involved in teaching in the schools, however, sensitivity to differences between students or the ability to analyze the complexity of classroom interaction can also be considered as tools that are typically used by teachers and that researchers may adopt.

Additional codes in the coding schemes were based on other elements of the research questions and interview guidelines, such as characteristics of cross-professional collaboration (reasons for collaboration, division of roles and tasks, communication). We used MaxQDA (version 10) for coding the interview fragments.

The next phase was to analyze the data in two steps in order to answer the first research question: Which learning mechanisms are characteristic for boundary crossers in collaborative R&D projects? The first step was to select all interview fragments per participant on experiences of boundary crossing, to which a relevant code had been assigned (roles, tasks, tools, and objects). We placed these fragments in within-site matrices per project. For each participant a row was used. The codes (roles, tasks etc.) indicated the columns (Miles & Huberman, 1994). The second step was to interpret the information in the matrices in terms of one of the four learning mechanisms. We decided to characterize each participant with one learning mechanism that suited the situation at the end of the second year of the projects. We will explain this for every learning mechanism:

- *Identification*: School leaders, teachers, and researchers who talk about having become aware of the peculiarities of ‘the other’ practice and how it differs from their own practice, will be characterized with this learning mechanism.
- *Coordination*: Characteristic for school leaders, teachers, and researchers who illustrate their work in the project as temporarily using both tools and objects from ‘the other’ activity system and their own, without this leading to real changes in the way they do their own work.
- *Reflection*: Characteristic learning mechanism for school leaders, teachers, and researchers who make perspective (i.e. understand and have knowledge of the other and their activity system) and take perspective (i.e. take the other into account, with respect to their own activity system). They use their new understandings of others and their activity system while they are collaborating.
- *Transformation*: This learning mechanism is characteristic for school leaders, teachers, and researchers who expand their professional ways of working with new tools and objects of the other activity system.

For every boundary crosser – school leader, teacher, and researcher – a learning mechanism was designated. This meant that each project was characterized by three learning mechanisms.

In the next phase of data analysis we examined data with regard to the second research question: How are types of cross-professional collaboration and (combinations of) learning mechanisms of boundary crossers related? Utilizing the result of the first analysis, we performed a cross-site analysis (Miles & Huberman, 1994). We set up a matrix in which the learning mechanisms for every project would be visible at a glance. For this purpose we put the learning mechanisms for every boundary crosser (school leader, teacher, and researcher) in the matrix and sorted them per project. Then we clustered these data per prevailing learning mechanisms, for example all projects that included boundary crossers who were transforming, were put together. Thereafter we placed the types of cross-professional collaboration (resulting from analyses in a previous project, see Appendix B) next to the projects for the purpose of answering the second research question. Finally, we selected five projects to be described as case studies to illustrate the combinations of learning mechanisms of school leaders, teachers, and researchers that occurred.

An audit was performed during the process of analysis by a researcher external to our research team. We discussed arguments for data selection and reviewed decisions concerning data analysis of interview fragments. The result of the audit provided us with a confirmation of the steps we took in the analysis. We adopted an advice to select additional interview fragments of participants that concerned their perspective of the learning of other school leaders, teachers, and researchers in their project. Taking the perception of other participants into account enhanced the triangulation of the data. As a second form of audit, the research team discussed all the steps in the process of analysis and its outcomes, and where necessary the primary data were rechecked (Miles & Huberman, 1994).

## **Results**

### **Boundary crossers and learning mechanisms**

In this section we will answer the first research question: Which learning mechanisms are characteristic for boundary crossers in collaborative R&D projects? We will focus on the extent to which each learning mechanism occurs with the school leaders, teachers, and researchers, and on what these mechanisms exactly entail in the context of R&D projects in Dutch secondary schools.

### *School leaders*

All school leaders in the nineteen projects were characterized as boundary crossers. Different learning mechanisms occurred.

*Identification* is characteristic for three school leaders who were involved in an R&D project as project managers (Project G, O and P, see Table 1). They purposefully have chosen to let researchers perform the study, and to be informed about the research itself, without being involved in the actual research activities. In the case of one project (G) this had led to dissatisfaction of the school board, especially concerning the communication of research results:

Last year, I have noticed that the researchers had a very leading role in this project and that we did not have a huge say in it. In the past weeks we have had conversations with the researchers and we actually told them: if there are research results, we would like to do something with the results [in our practice] (Interview school leader, Project G).

*Coordination* is typical of two school leaders (Project F and Q). The school leader in Project F had a main task in encouraging teachers to design new educational approaches for highly gifted students. He combined this task with collecting data on the intentions and actions of these teachers, by recording conversations, making notes during meetings and conducting in-depth interviews. During the project he was shifting quickly back-and-forth between the object of school development and knowledge building, but he encountered the problem of time management:

The difficulty lies in processing the data. I am not able to do that now. It is too much work and I am busy with developing the school at the same time. Developing the school has my priority now (Interview school leader, Project F).

*Reflection* is the main learning mechanism for five of the school leaders. For example the school leader in Project S, who explained his role in the project:

I am more engaged in exchanging ideas with the researchers on methodology and those kinds of things than I used to do, though that is not my expertise of course. But I have some thoughts about this and certainly about how to improve this [making use of research] in our school (Interview school leader, Project S).

He indicated that his perspective was expanded with the viewpoints of the researchers and his learning process contributed to a better understanding of how research can be used for more than knowledge creation only.

*Transformation* is characteristic for nearly half of the school leaders at the end of the second year of the project. These school leaders explained that they experienced changes in their knowledge and skills as a result of performing research activities or stimulating teachers to perform research in school in an earlier stage of the project. As the project continues they said they have obtained more knowledge on how to stimulate colleagues to conduct studies in school, how to use research results for school development and they know how to perform a study, as is the case with the project manager of Project C:

I have learned that you should not search immediately for a solution, but that you should perform a solid research: an accurate analysis of the problem, good desk research, research design, research question, research goal, how to collect data. Let's say, all steps in research. (...) If I compare this with one year ago... then it is an enormous development. I can see a huge difference in the way everybody is engaged in the project (Interview school leader, Project C).

Thus these school leaders actually integrated tools and objects in their practice that traditionally belonged to the activity system of researchers. They accounted on the development of a more inquiry-based attitude in their daily work: they started asking more questions and being more critical towards their own actions. This can for instance be noticed with one of the project managers of Project D:

I have become aware of changes in my own research attitude and that is, I must say, quite a strange sensation. I performed several studies myself earlier. Finally I came into a position in which I only 'did, did, did' and actually asked a small number of questions. I have noticed that I get to use this research attitude, which I found again in part in this project, in the guiding and directing of the school, in conversations with Ronald [project member], on moments when I am at someone else's field. ... but also that you would like to be more systematic in taking decisions. ... I also become more critical towards my own actions in the classroom. These are major gain points (Interview school leader, Project D).

### ***Teachers***

Almost all teachers who were involved in the projects could be characterized as boundary crossers, see Table 1. In four projects no teachers were involved in development or research activities; these teachers were not crossing boundaries to the activity system of research. In the other fifteen projects teachers were involved in tasks such as the construction of questionnaires and data interpretation. The learning mechanism of *identification* was not found with teachers.

*Coordination* is typical of none of the teachers, as there were no teachers who showed effortless movement between their teaching and their research activities in the project. Possibly the reason for this is that most teachers saw their research activities as an extra activity on top of their school work. Therefore a smooth transition from teaching to research activities and back again was not achieved.

*Reflection* is the characteristic learning mechanism of six teachers who were able to take the perspective of the researcher as they participated in the project. An example of reflection was seen with the teachers in Project O. In the course of the project the researchers decided to increase the engagement of the teachers in the project by 'letting them distribute and take in the questionnaires [...] and to involve them in the [construction of the] questions.' (Interview researcher, Project O). As part of the evaluation of the digital method implemented in their lesson programs, the teachers were asked to reflect on what they had done and what they had learned from implementing the new lessons. One of the teachers mentioned in her interview that she was not used to asking questions and reflecting on her lessons; she was used to accept things the way they go. Her attitude gradually changed to asking more questions thanks to the introduction of a reflection log. She also pointed out that she was becoming more interested in reading about education studies due to participating in this project. However, she did not experience an easy fit of these new activities into her daily routines.

I try to read more about education and education research, as I am more aware of the possibilities of these studies. Unfortunately, I am not able to read everything, as I am busy with other things as well. But if I notice something related to educational studies or education in general I try to read that and check if it could be useful for myself (Interview teacher researcher, Project O).

These six teachers take the perspective of researchers, but their learning processes cannot be characterized as *transformation* since there are no indications that the perspective taking transfers to situations beyond the context of the particular R&D project.

*Transformation* is characteristic for eight teachers, who all were involved in a project as teacher researchers. By working with the tools and objects of the academic research field, they expanded their professional ways of working as a teacher. They said they obtained a critical stance, they got a helicopter view on broader school issues, they started using test scores for analyzing student

progress, and they used research results and educational literature in improving their teaching. The teacher researcher in Project S explained explicitly:

You become more critical on what is happening in school and you say less easily you can't change things. So you remind yourself to introduce this on the agenda of the next meeting (Interview teacher researcher, Project S).

Another example is the teacher researcher in Project A who was challenged in the project to think about other things than her daily classroom work, in this case about school-wide policy on language and mathematics. Her role in research encouraged her to 'become more than a mathematics teacher'. She applied new (research) tools in her daily work, for instance interpreting the test results of her students. This altered her objects with her students, especially the ones who scored low on tests. She decided to design additional lesson materials for these students on the basis of her interpretation of the test scores. She also became more aware of 'what is happening' in the educational field about language and mathematics, and created the habit to ask questions such as what works and what is effective for students.

### ***Researchers***

All researchers in the R&D projects can be characterized as boundary crossers, see Table 1.

*Identification* is the typical learning mechanism for four researchers. For example the researcher of Project R who initiated a collaboration with a supervisor who was able to provide the school with advice. By using this strategy the researcher was able to keep out of school development issues and to work at a distance from the school during the period of data collection and analysis. The role and practice of the researcher remained as they were before the project.

*Coordination* is characteristic for two researchers. In their perception 'the role of a researcher is close to the role of an adviser' (Interview researcher, Project P). They shifted smoothly from the role of providing advice to the role of conducting the research. This learning process of these two researchers is not seen as *reflection* or *transformation*, because the tools used and objects aimed at in their role as a researcher were not changed. In their role as researcher they were collecting data in the schools, and in their role as adviser they were thinking along with school leaders and teachers about questions concerning teaching and learning.

*Reflection* is typical of five researchers. They indicated that they view themselves primarily as researchers, but in the course of the project learned to understand and take into account the perspective of the school. For instance, in the interviews they told what they learned from the school: about the role of school leaders who stimulate their teachers to instigate school development; to move up deadlines for teachers who have urgent school matters; the specific abbreviations that are used in the school. In fact, they got to know the needs in school. The skills they have learned are skills needed for doing practice-based research, e.g. being flexible in making plans and adjust use of language to the level of what is understood in the school. When these researchers were asked to provide the school with advice during the project, they choose not to get involved in guiding and directing the development in the school, which is the case with the next learning mechanism.

*Transformation* is the characteristic learning mechanism for six researchers who increasingly identified with the schools' object, namely providing conditions for good education and developed 'tools' that originally belonged to teachers such as an awareness of the complexity of teaching practice. In other words: their research approach became practice engaged. These researchers became involved in decision-making processes and came to see research and development as interwoven processes. They wanted to think along with school leaders and teachers about the design of an innovation or the implementation of a new pedagogical approach in lessons that was to be examined, as they saw it as the operationalization of a theoretical idea that can thus be tested. They made preparations with the school leaders on, for example, the content and form of meetings with teachers, as they were aware of the importance of support within the school team for the innovation in order to do a valid evaluation.

### **Learning mechanisms and cross-professional collaboration in the projects**

After characterizing learning mechanisms for categories of boundary crossers, we will now focus on patterns in the occurrence of learning mechanisms of school leaders, teachers, and researchers at the level of the R&D projects, and on how (combinations of) learning mechanisms relate to different types of cross-professional collaboration. Thus we will answer the second research question: How are types of cross-professional collaboration and learning mechanisms of boundary crossers related? First, we will relate the four types of cross-professional collaboration to the occurrence of the learning mechanisms and secondly we will present five case studies that provide an illustration of how different learning mechanisms may play out in R&D projects.

### ***Cross-professional collaboration and learning mechanisms***

Table 1 shows the type of cross-professional collaboration and the (combination of) learning mechanisms for each project. This reveals the following patterns.

- School-directed collaboration co-occurs in four projects, with the combination of *transformation* for school leaders and teachers, and *reflection* for researchers. In school-directed collaboration school leaders and teachers took responsibility for performing research in their school. This implies learning processes that involve mastering tools that are used in research and developing objects aimed at understanding and evaluating the development in school.
- School- and researcher-directed collaboration is related to two combinations of learning mechanisms. In three cases of school- and researcher-directed collaboration we see *transformation* for all professionals, and in three cases *reflection* for school leaders and teachers, and *transformation* for researchers. Researchers in all of these projects had an active role as sparring partners for school leaders and teachers, and provided support on decisions to be made on school issues. School leaders and teachers whose learning mechanism is characterized as reflection created a good understanding of the perspective of researchers in the project, for instance when discussing the research plan. School leaders and teachers whose learning mechanisms is characterized as *transformation*, additionally adopted research tools and objects such as analyzing students' results and drawing substantiated conclusions.
- School- and adviser-directed collaboration is related to the combination of *identification* for the leaders and teachers, and *coordination* for the researchers. In these two projects the researchers combined their roles in performing research with the role of adviser. The school leaders' learning mechanism is *identification*, as they were informed about the research, but were not involved in any research activity.
- Researcher-directed collaboration is related in three projects to the learning mechanism of *identification* for researchers, who were not involved in stimulating or thinking along with school development processes. This is combined with learning mechanisms of *reflection* and *coordination* on the side of school leaders and teachers. They showed less time investment and had little input in the research compared to other projects.

### ***Combinations of learning mechanisms in five projects***

In this section we will illustrate five combinations of learning mechanisms by introducing five case studies: one project of every cluster of learning mechanisms as shown in Table 1.

▼ **Table 1** | Boundary crossers, learning mechanisms and types of cross-professional collaboration

Project code	Presence of learning mechanisms in the R&D projects			Type of cross-professional collaboration
	School		Research institute	
	School leader	Teacher	Researcher	
	Transformation with all participants			
Project C	T	T	-	School-directed
Project H	T	T	T	School- and researcher-directed
Project I	T	T	T	School- and researcher-directed
Project J	T	T	T	School- and researcher-directed
	Transformation and reflection			
Project A	T	T	R	School-directed
Project B	T	T	R	School-directed
Project D	T	X	R	School-directed
Project E	T	T	R	School-directed
Project N	T	R	R	School- and adviser-directed
	Reflection and transformation			
Project K	R	R	T	School- and researcher-directed
Project L	R	R	T	School- and researcher-directed
Project M	R	R	T	School- and researcher-directed
	Coordination and identification			
Project F	C	X	-	School-directed
Project Q	C	X	I	Researcher-directed
	Identification and coordination			
Project O	I	R	C	School- and adviser-directed
Project P	I	X	C	School- and adviser-directed
	Other combinations			
Project G	I	?	I	School-directed
Project R	R	R	I	Researcher-directed
Project S	R	T	I	Researcher-directed

Note: I = identification, C = coordination, R = reflection, T = transformation, X = no boundary crossing, - this role is not present in this project, ? = no information available.

### ***Identification and coordination: Project P***

The schools involved in Project P all have a large proportion of learning-supported students. These schools qualify for extra funding to realize specific interventions for these students, such as creating smaller group sizes or implementing digital systems for test scores. The aims of the R&D project were firstly to provide an overview of the efficient interventions in the schools and secondly to collect and analyze data of students in a systematic manner.

This project is an example of a 'school- and adviser-directed collaboration'. In group meetings both researchers and advisers met with the school leaders four times a year. In total four researchers and advisers were involved during the project. The researchers and advisers made decisions on the aim of the research and research activities in close alignment with the wishes of the school leaders. In between the group meetings, the researcher had short meetings with school leaders in their school. The school leaders were involved in this project as experts of their school situation, and the researchers interviewed them. They made decisions on the school level, for instance on the kind of interventions and on funding issues. Teachers were not aware of the research activities in school; actually they were not crossing boundaries. The school leaders were not involved in research activities either, but they were informed about the progress of the study by the researchers.

Teachers were hardly actively involved in the project and no boundary crossing of teachers occurred. The learning mechanism of the school leaders can be characterized as *identification*. As one of the school leaders explained, he deliberately did not intervene in the work of researchers: 'They operate autonomous, I won't interfere in that.' (Interview school leader, Project P). It was a conscious decision to remain true to his own role and tasks. However, when the research results were available the school leaders made plans to use these to further develop interventions aimed at improving conditions for their learning-supported students.

The learning mechanism of the researchers can be characterized as *coordination*; they show a smooth transition from their activity system to the one of the school. Melissa<sup>1</sup>, one of the researchers illustrated her vision on advice and research, which is a typical example of *coordination*:

Advice and research was not so strictly separated. There are differences between schools in which the research role was more emphasized and schools in which the adviser role was more emphasized. ... While collecting information, we also wished for setting the schools in motion. This involves providing advice to the school. You don't watch at a distance to what happens on the school, but you are

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<sup>1</sup> All names of participants are pseudonyms.

more or less steering the school by asking critical questions to make them clear what they actually want (Interview researcher, Project P).

Another manifestation of *coordination* is that researchers and advisers took responsibility for translating the research results to the specific situation of each school involved in the project.

### ***Coordination and identification: Project Q***

The school involved in Project Q has implemented special lessons to motivate students to read books. Project manager Bart – a school board member accountable for education quality in the three locations of the school – was responsible for the integration of the reading lessons in the school curriculum and for the communication with his colleagues and the researchers. The researchers were involved in evaluating the reading lessons, which was the question of the school. At the same time they were concerned with the development of a new reading instrument and they were keen on receiving test results for this instrument. To achieve this research purpose was the researchers' main concern, which is a characteristic element of a 'researcher-directed collaboration'.

The learning mechanism of the researchers can be characterized as *identification*. In fact, researcher Linda was working at a distance of the school practice:

On moments that it was really necessary for the research, I was there. But I did not visit the school very often by means of following them. That would not be in line with the character of this research. No, it was not a case study research; in that case you would be more closely involved (Interview researcher, Project Q).

Project manager Bart's learning processes can be characterized as *coordination*. He played an active role in the translation of the research results to teachers and school leaders:

I am fortuitously a mathematician, so I am able to tell something about numbers and statistics. Well, I know of course the school practice of our school much better. I know from the people in our school what their background is and what they are doing, so in this sense I can establish a link (Interview school leader, Project Q).

Bart was shifting back-and-forth from the activity system of the academic field to the school field, while translating the results of the study for his school colleagues. He was aware of using other tools than he used to do, such as the interpretation of difficult-to-read research results.

### ***Reflection and transformation: Project K***

Project K is the follow-up project of Project S. The aim of Project S was to examine effects on students' knowledge in physics of the implementation of two digital games. This project ended after one year and both school leaders and researchers considered the results primarily of interest for the knowledge base of the researchers. The school board realized at that point that a new study on games could also stimulate professional development of teachers and school development as well. The 'researcher-directed collaboration' in Project S altered in a 'school- and researcher-directed collaboration' in Project K.

The school leaders had a better understanding of the options of research tools and objects in their school than one year before; they realized how research could be used for more than knowledge creation only. Their learning mechanism can be characterized as *reflection*.

The researchers, in the meantime, went through a learning process that can be characterized as *transformation*. They were already involved in Project S. The decision of the school board changed the expectations towards the role of the researchers. One of the researchers, Jim, explained his new role:

I am actually for the most part supervisor and adviser in this project. In the previous project I was more a co-researcher. In this project performing the research is the main task of Kathryn. Supervising and bringing in the theoretical frameworks lies with me, as is supervising and creating the games (Interview researcher, Project K).

At first, Jim experienced hesitations and minor conflicts with his changing role:

Sometimes I think we have to direct the process more tightly. But then we see that that does not work, so we try more personal supervision [of the teachers]. These are all different perspectives, which we could not have predicted, but those came on our path simply by experiencing this in practice (Interview researcher, Project K).

He learned from his experiences and also about the behavior of teachers and their daily work:

I learn a bunch from this, especially in a practical manner. We have been thinking a lot and trying to puzzle out how to place this creative process in the hectic pace of the day. My beliefs and ideas about research and practice have altered because of the experiences that you encounter (Interview researcher, Project K).

Jim's beliefs and ideas about research and practice were still changing at the time of the interviews, but several changes were already visible in his actions. He changed for example an institute-based course on games to a course in which teacher's concerns and questions were the starting point. The typical processes associated with *transformation* can be seen: at first the researchers were confronted with a new situation and they recognized a shared problem with the school leaders and teachers. They had to find a new balance in the relationship with the school leaders and teachers and became more school-centered in their actions; they paid more attention to questions that were raised by the teachers and adopted a more supervising task.

### ***Transformation and reflection: Project A***

The research purpose for Project A was to enhance the students' skills in Dutch language and mathematics by implementing specific curricula designed by teachers. In this project school leaders and teacher researchers were conducting most of the research and additionally stimulated research activities in school. The type of cross-professional collaboration was 'school-directed collaboration'. At the start of the project a project team was composed with school leaders and teachers Randy, Iris, Laura, Manuela, and with researcher Helen. Randy was project manager in the first year and again in the final months of the second year. He had studied Dutch language education and he was working for over fifteen years at this school. He was also involved as teacher researcher, together with Iris and Laura. Manuela was member of the school board.

The learning mechanism of the school practitioners in project A can be characterized as *transformation*. The project manager learned of his attempts to put research in a more central position in his school. He contributed to changes in school, for example by analyzing data on students and encouraging colleagues to interpret the results and formulate consequences for their own teaching of these students. Important in this context was his ambition to realize a move from the research bureau to the school in responsibility and the performance of research tasks:

Yes that is one of the goals we have set: to be able to perform research tasks on our own after three years with the research bureau. This entails actively approaching the research bureau to teach us how to perform research. Not only performing research, but also to make sure this research will be integrated in our school policy. It involves a research attitude and educating people on this issue. That is something more than just calculating some figures (Interview school leader, Project A).

This move required research competences and a research attitude of teachers, such as having a critical and reflective stance towards school interventions. Randy's aim was to have teacher researchers to take up more research tasks, for example make use of the instruments initially introduced by the researcher. Researcher Helen observed that the teachers involved in the project started asking critical questions on the research were thinking along and were actively reading research reports.

In the first year Helen's own professional attitude towards her work could be characterized as *identification*. She said: 'I am a researcher. I prefer to stay that way' (Interview researcher, Project A). She knew the school really well, in her own words. She was closely connected to the school for over five years. The contact started during a former R&D project at the same school, when another researcher was leading the research and she was carrying out the research.

We know the way to school, we are familiar with the school culture, you are a familiar face. For example with the interviews and consultation you are familiar with the people. You are used to the working manners, you know the background and context, the differences between school locations. We have former experiences with distributing questionnaires and now we are able to do it right away (Interview researcher, Project A).

After two years Helen's learning processes can be characterized as *reflection*. She still did not want to interfere directly in school issues, but felt connected to the situation in the school. Her strategy was to take the perspective of the school board, stimulate school leaders and teachers to reflect on the research results and let them take decisions based on the results.

### ***Transformation by all professionals: Project H***

Project H had been started with three intermingling research and development goals in mind: to increase the level of reading skills of students; to increase the research competences of teachers by facilitating them to conduct a study in the subject of Dutch language; and to document effective elements in the training the teacher researchers would take. From five different school locations one teacher in Dutch language was asked to join in the project. They received a training to become teacher researchers with a central focus on research skills: they learned how to read academic literature, formulate research questions, and collect and analyze data. The primary concern of the researcher, Paula, was assisting the school on the goals that were set for the project. She advised teachers in their studies by providing input on recent literacy studies. Paula worked at a university on the department of teacher education and was experienced with educating

student teachers. This project is an example of ‘school- and researcher-directed collaboration’.

We characterized the learning of both the school leaders and teachers, and the researcher as *transformation*. Susan was managing the project on both development and research activities. She was staff member of the school board. Susan was working with Paula on this project as a team: she saw Paula as a sparring partner on all kinds of issues concerning the project:

We really work closely together. Together we prepare the new group meetings for the teachers. Between every meeting we have an appointment. I make the agenda and she complements it if necessary. After this we talk about what we are going to do. Often, we agree on this very quickly. It is very pleasant (Interview school leader, Project H).

Researcher Paula agreed on this. She illustrated that they shared tasks such as supervising teachers and organizing the project:

We still prepare the meetings together and determine the agenda and well, we do a debriefing together (Interview researcher, Project H).

Paula pointed out in her interviews that she primarily had a role as researcher, but that she also provided advice to the project manager and supervised the teacher researchers. Susan subscribed this. In the first year of the project, Susan was not really involved in the studies of the teacher researchers. This changed in the second year, as she explained:

I really have helped one of the three [teacher researchers]. I have conducted four out of eight of her interviews. Also to experience... that I just knew for myself exactly ... well, what is happening in such an interview (Interview school leader, Project H).

Susan was convinced that conducting research by teachers is something that is important for the school, because research competences will enhance their professional attitude, also in their work as a teacher. After two years Susan was generally satisfied with the process the teacher researchers had gone through. Teachers had obtained a research attitude and started analyzing data they themselves had collected. In the meantime Susan had also engaged colleagues in the studies undertaken by informing them about the progress and results of the studies.

## Conclusion and discussion

At the core of this study are the notions that several learning mechanisms may come into force when school practitioners and external educational experts in R&D projects cross boundaries. In order to create a better understanding of the learning of boundary crossers in these projects we interpreted their learning in terms of learning mechanisms: *identification*, *reflection*, *coordination*, *transformation* (Akkerman & Bakker, 2011). A first result of this study is the observation that almost all school leaders, teachers, and researchers in the nineteen R&D projects in secondary education in the Netherlands indeed crossed boundaries between the academic research field and the school field and the other way around. Crossing boundaries contributed in different ways to the learning of the school leaders, teachers and researchers (Edwards, Lunt, & Stamou, 2010).

### Conclusions

By looking through the lens of learning mechanisms we generated a better understanding of the processes in which learning of professionals took place in R&D projects. Our first research question was: which learning mechanisms are characteristic for boundary crossers in nineteen collaborative R&D projects? About half of the school leaders' and teachers' learning mechanism were characterized as *transformation*. By performing research in their school and engaging other colleagues in the research, they expanded their professional ways of working with tools and objects that are typical for research. These teachers, usually having a role as teacher researcher, for example mentioned using test scores for analyzing student progress and developing a more critical stance towards school issues more generally. School leaders started using tools and objects of researchers as well. They mentioned for instance taking decisions in a more systematic, substantiated way.

We observed that *reflection* is characteristic for most of the other teachers involved in the projects and for a few school leaders. Such teachers and school leaders mentioned having developed a better understanding of the value of research. For example, they started reading about educational research and are asking more questions about their own practice now. However, they were searching how to fit research tools and objects into their daily routines.

*Coordination* and *identification* were less common learning mechanisms in the case of school leaders and do not occur with teachers in the R&D projects. *Coordination* for school leaders entailed shifting between their role as a school leader and performing research tasks, without these becoming integrated. These school leaders were able to translate research results to school colleagues.

*Identification* for school leaders entailed being interested in research results that are relevant for school development, without becoming involved in the research itself.

The learning mechanism of half of the researchers is characterized as *transformation*. These researchers developed a practice-engaged research approach; they came to see research and development as interwoven processes. They identified with the schools' object of providing good education and became involved in decision-making processes on school matters and in co-developing new pedagogical approaches. They also became more aware of the complexity of teaching practice.

*Reflection* is characteristic for a third of the researchers in the nineteen projects. This includes researchers who took the perspective on school development issues into account as they perform research, for example by moving up deadlines for teachers who have urgent school matters. These researchers have decided not to guide or direct the development in school.

*Coordination* and *identification* are characteristic for a few researchers. *Coordination* for researchers entails using tools and objects for conducting research as well as adapting tools and objects to stimulate school development. However, their tools and objects as a researcher were not influenced by using tools and objects of school leaders and teachers. *Identification* for researchers entailed working at a distance from the school and being aware of school issues, but at the same time they had chosen not to be involved in these school issues.

The learning of boundary crossers was situated in R&D projects in secondary education in different types of cross-professional collaboration. This notion leads to our second research question: How are types of cross-professional collaboration and learning mechanisms of boundary crossers related? Per type of collaboration distinct combinations of learning mechanisms occur. School-directed collaboration seems to relate to learning of school leaders and teachers that can be characterized as *transformation* and a researcher's learning mechanism of *reflection*. School leaders and teachers were responsible for guiding and directing the research in these projects. School- and researcher-directed collaboration is a type of collaboration in which teachers and school leaders have the main responsibility for performing research in their school and with researchers who provide support on decisions on school matters. It is related to two combinations of learning mechanisms: *reflection* for school leaders and teachers and *transformation* for researchers, and *transformation* for both school leaders and teachers and researchers. School- and adviser-directed collaboration, in which advisers share the responsibility of the research and development activities

in the project, is related to a combination of *identification* for school leaders and teachers, and *coordination* for researchers. Researcher-directed collaboration is related to the learning mechanism of *identification* for researchers, which is associated with the role of these researchers who have additional reasons for the collaboration and work at a distance from the school. So, depending on how school leaders and teachers, and researchers are collaborating, they are encouraged to cross boundaries between the school field and academic research field, allowing different learning processes to come into force.

## Implications

Our study has implications for several areas. As the examination on nineteen Dutch R&D projects shows, school leaders, teachers, and researchers, can learn from new roles and tasks in these projects as they cross boundaries. They adopt new tools and objects as they engage in the project, especially in the case of *transformation*. These results on shifting roles confirm the study on boundary crossers of Max (2010), in which several student teachers become co-creators and co-researchers, as they are involved in projects in their school with colleagues. Our results on the tasks and roles of teacher researchers confirm other studies that search for solutions for the perceived gap between academic research field and school practice (Broekkamp & Van Hout-Wolters, 2007; Wagner, 1997; Williams, 2002). For example, Janssen, Westbroek, Doyle and Van Driel (2013) highlight the ability for teachers to connect practical knowledge to more theoretical knowledge derived from research, whereas Rust (2009) demonstrates the role teacher researchers can take in translating knowledge from the research field to the school field. In the light of closing the gap between research and practice, it is also important to focus on characteristics of cross-professional collaboration. Strong linkages between researchers and practitioners are necessary in order to create a good understanding of each other's tools, objects and motives, as is mentioned by other authors (e.g. Hora & Miller, 2011; Tsui & Law, 2007; Williams, 2002). Coburn and Stein (2010) emphasize in this light the need for all parties to communicate goals and strategies, in order to create a shared framework and commitment in a project. Our study shows that researchers can work more closely to the school practice or decide to work at a distance, as they are involved in R&D projects. The work of Van de Ven (2007) on engaged scholarship provides insight into an approach for researchers on how to build a relationship with practitioners with the motive to obtain a better understanding of the complex school practice. The researchers' decision for spending time in schools and providing greater accountability to the practitioners are important elements in engaged scholarship (Van de Ven, 2007).

## Future studies

The implications for both school practice and research institutes of our study are based upon R&D projects that were part of the same funding scheme. One of the aims of the funding organization was to enhance and stimulate the exchange of knowledge between the research field and the school field. The application for the funding scheme itself could have been an indirect incentive for some of the professionals to cross boundaries in the project. So, it is important to keep the funding scheme of the R&D projects in mind, while interpreting the results. Besides this, it is not known if other colleagues in the schools in which R&D projects were situated, learned from the boundary crossers in the projects.

In future studies on R&D projects it is interesting to integrate more perspectives on the changes in the practice of schools and research institutes, for example by asking other colleagues their opinion on perceived changes in the activity systems. Regarding the inclusion of all perspectives, it might be interesting to take more systematically into account two other groups in a future study on learning mechanisms: advisers and supervisors who are involved in R&D projects. As part of their daily work, advisers and supervisors are crossing boundaries from their activity system to the school practice (e.g. Akkerman, Bronkhorst, & Zitter, 2013). Examples of these roles for R&D projects are providing advice to school leaders and supervising teachers in their developing work or research activities. However, next to crossing boundaries to the school practice, advisers and supervisors might also cross boundaries to the academic research field while they are involved in an R&D project. A future study that includes these professionals might provide insight in the kind of learning mechanisms that are present in these cases.

Another research question for a future study would be to examine what kind of changes in the actions of the professionals in R&D projects leads to what kind of alterations in school practice. The results of our study demonstrate a promising contribution that practitioners can make to alter their school practice, especially when these professionals' characteristic learning mechanism is *transformation*. The four learning mechanisms might have a different relation with alterations in the activity systems of the professionals.

A final suggestion for future research is to examine developments in time in how school leaders, teachers, and researchers are collaborating in R&D projects in secondary education. If changes occur in how school leaders, teachers, and researchers are collaborating, possibly resulting in a different type of cross-professional collaboration, then this might be related to the occurrence of learning mechanisms of boundary crossers in the project. It is of importance to investigate these kinds of changes that can occur in R&D projects in schools

in order to provide insight in how school leaders, teachers, and researchers can collaboratively work on practice-based research that contributes to school development.

In this study we have demonstrated that boundary crossers pass through several learning processes that are related to their role and tasks in the R&D project. This contributed to a growing awareness of each other's tools and objects. School practitioners and external educational experts took up new tasks and included new perspectives in their actions, through collaborating in a R&D project. This resulted in several combinations of learning mechanisms in the projects, which played out differently for the professionals and their collaboration in the project. The combination of *transformation* with all parties is the most far-reaching way of crossing boundaries. These school leaders and teachers, for instance, obtained a research attitude and started analyzing data they collected, and these researchers, for example, engaged in decision-making processes on school issues. *Transformation* entails a closer interaction between school practitioners and external educational experts, in which tasks such as supervising teachers and organizing an R&D project were shared. The findings contribute to the understanding of boundary crossing in the context of R&D projects, as school leaders, teachers, and researchers learn from the other professionals' activity systems in relation to their own situation. By examining the learning potential of boundary crossing this study has further opened up the promising perspective of boundary crossing in education research as a useful framework to explore issues that concern the connection of professionals who function in different worlds.



## Appendix A

### Coding scheme, used for analyzing interviews

Code	Explanation
<b>R&amp;D project team</b>	
Project team; development	Composition of project team on the issue of development: names and tasks of project participants
Project team; research	Composition of project team on the issue of research: names and tasks of project participants
Changes in project team	Changes in project team; expectations for next school year; ways of transferring knowledge to new participants in case of changes in project team
<b>Project activities and output</b>	
Development activities	Progress in project activities on level of development and judgment on this issue; with attention to e.g. an innovation, professional development of teachers
Research activities	Progress in project activities on level of research and judgment on this issue; with attention to e.g. tests, questionnaires, analysis and reports
Role of research in the project	Role of research in the project, for instance informing school development and judgment on this issue
Progress in project	Project progress as planned or reasons for changes in planning
<b>Cross-professional collaboration</b>	
<b>Reasons for collaboration in project</b>	
Connection research institute-school	What connects research institute-school, e.g. research theme, previous history
Reasons for collaboration	Reasons for collaboration research institute -school in this project; interests of parties
Project goals	Project goals; research and development
Convergent or divergent reasons	Convergent or divergent reasons for collaboration and project goals; vision on development and research
Opinion on collaboration	Opinion on how collaboration research institute-school works out
<b>Division of roles and tasks in project</b>	
Role of project manager	Role, tasks, actions undertaken, and responsibilities of project manager in research and development
Role of school leader	Role, tasks, actions undertaken, and responsibilities of school leader in research and development
Role researcher/adviser/ supervisor	Role, tasks, actions undertaken, and responsibilities of researcher, adviser, supervisor in research and development
Role teacher(researcher)	Role, tasks and responsibilities of teacher(researcher); training and time and space facilitations; capable of performing research
<b>Boundary crossing</b>	
Crossing boundaries	Work like the other by making use of the world of the other (e.g. a teacher who designs questionnaires; a researcher who focuses on questions raised in school practice)
Changes in roles and tasks	Changes in roles and tasks through crossing boundaries
Changes in competences	Changes in knowledge, skills, attitude through crossing boundaries:
Changes in professional identity	Changes in professional identity through crossing boundaries

▼ Appendix A | Continued

**Communication structure in project**

Workplace researcher	Frequency of working at school or at institute by researcher
Contact person	Contact person at school for researcher
Time investment	Time investment in project in hours per week/month
Communication means	Means of communication between research institute-school: consultation, e-mail, phone

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**Involvement of researcher**

Distance of researcher	Researcher is closely involved or working from a distance
Decision making	Decisions on project issues taken by school or researcher
Dependence	Extent of interdependence between school and researcher
Trust	Building on each other's opinions and visions
Conflicts	Conflicting issues or disagreements in the collaboration
Rhythm	Tuning the rhythm of school issues and research activities, e.g. planning questionnaires outside school exam periods
Needs	Tuning needs of school and researcher in research and development

**Vision on research**

Vision on research, research engagement, performing research in school	Vision on research engagement, on who has to/can perform research in school: academic and/or school participants
Vision on research; goal and audience	Vision on practice-based research: enhancing academic knowledge and/or contributing to improvement of practice; audience for practice-based research (academic world and/or practice)
Vision of institute	Vision of school/institute on performing practice-based research in school; support on performing research

**Advancing and restrictive factors**

Advancing factors	Factors that are seen as advancing success, concerning output, activities and conditions, and collaboration
Restrictive factors	Factors that are seen as restrictive for success, concerning output, activities and conditions, and collaboration

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## Appendix B

### Characteristics of cross-professional collaboration in R&D projects

Project code	Reasons for collaboration	Division of roles and tasks and communication						Type of cross-professional collaboration		
		Direction and guidance		Role in research and time investment		External party				
		Development	Research	School leader	Time investment	Teacher researcher	Time investment	External party	Time investment	
Projects ABCDFG	Congruent	School	School and external party	Project manager	High	Present	High	Project manager, researcher, supervisor	High, sometimes low	School-directed collaboration
Projects HIJKLM	Congruent	School and external party	School and external party	Project manager	High	Present	High	Project manager, researcher, adviser, supervisor	High	School- and researcher-directed collaboration
Projects NOP	Congruent	School and external party	School and external party	Project manager	Low	Not present	Low	Project manager, researcher, adviser, supervisor	High	School- and adviser-directed collaboration
Projects QRS	Additional	School and external party	External party	Attune to development	Average	Present	Low to average	Project manager, researcher, adviser, supervisor	Average to high	Researcher-directed collaboration