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Closing the feedback loop: a productive interplay between practice-based research and school development through cross-professional collaboration in secondary education

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A recurrent discussion in the field of education is how to build linkages between educational research and school practice. Cross-professional collaboration between researchers and school practitioners can contribute to the interplay between practice-based research and school development. The aim of our study is to obtain a better understanding of how a productive interplay between practice-based research and school development is established in the context of 19 research and development (R&D) projects in secondary education. Data from semi-structured interviews with school practitioners and researchers involved in the projects, observations of project meetings and document analysis were used. A productive interplay, in which practice-based research informed school development, was found in two-thirds of the R&D projects. Important conditions in these projects include closing the feedback loop from research to school practice, and making clear agreements on communication and on division of roles and tasks.

Keywords: interplay; practice-based research; school development; cross-professional collaboration; research and development projects

1. Introduction

Academic researchers in education build upon existing knowledge and create new knowledge on various topics, for instance on students' learning and motivation, teachers' practice, curricula, school systems or educational policy; which in fact are all situated in education practice. Yet a recurrent point of discussion is the weak alignment of educational research and school practice (McLaughlin and Black-Hawkins 2004). It is often stated that a strong linkage may contribute to improvements in educational practice (Hargreaves 1999, Vanderlinde and Van Braak 2010, Levin 2013). As Burkhardt and Schoenfeld (2003, p. 3) have observed, however, there is 'a lack of credible models of employing educational research to shape educational practice'.

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Recently, several authors (for example, Penuel *et al.* 2011, Ormel *et al.* 2012, Bronkhorst *et al.* 2013, Levin 2013) have made a plea for researchers and practitioners to collaboratively improve educational practice. Such collaboration is supposed to enhance the interplay between practice-based research and school development. However, it is not clear under what conditions practice-based research actually informs school practitioners to change their school practice.

In this article we report on a multi-case study analysis of collaborative research and development (R&D) projects in schools. In these R&D projects, which were part of a funding scheme, practice-based research was performed in schools with the aim to inform school development. The R&D projects set the context for cross-professional collaboration between researchers and school practitioners. We refer to cross-professional collaboration as a process in which a diversity of professionals (i.e. school practitioners and researchers) come together with divergent reasons to reach project goals via guiding, directing and performing R&D activities and through mutual communication (Wagner 1997, Van de Ven 2007, Penuel *et al.* 2011). In this article we explore how a productive interplay between practice-based research and school development through cross-professional collaboration is established in R&D projects.

2. Practice-based research and school development

In the debate on the gap between research and practice, Gibbons *et al.* (1994) made a useful distinction between two types of knowledge development; called Mode I and Mode II. Mode I is characterized by linear linkages between the academic field and school field. Researchers have the responsibility to perform research and publish results in international journals, after which results are disseminated to practitioners who have the responsibility to read and use them. Mode I contributes to the debated gap between the academic field and the school field. Mode II encourages the emergence of communities of learning in which researchers and practitioners collaborate to create and use new knowledge. The knowledge transfer between both fields is thereby stimulated (Rynes *et al.* 2001, Nutley *et al.* 2008, Ormel *et al.* 2012).

Performing practice-based research can be situated in Mode II; for instance, evaluation studies, effect studies or design research. The aim of practice-based research is to generate useful knowledge on and for educational practice (McLaughlin and Black-Hawkins 2004, McKenney and Reeves 2013). Practice-based research can provide insights into specific problems in school practice and support practitioners in their work (Earl and Katz 2006, Broekkamp and Van Hout-Wolters 2007, Oancea and Furlong 2007). The process of performing practice-based research is often iterative, consisting of multiple cycles of problem analysis, implementation and evaluation. Particularly in design research, interactive cycles of design, development, testing and evaluation are performed (Bauer and Fisher 2007, McKenney and Reeves 2013). The process of school development is typically iterative as well. It starts with a vision and a plan, and is followed by the occurrence of changes in practice. Systematic evaluation of such changes, however, is uncommon (McLaughlin and Black-Hawkins 2004, Slegers and Leithwood 2010). School development refers to the activities in a school that aim at improving educational practices. These activities may range from alterations in teaching practice, to new forms of collaboration in teams, to changes in the structure and culture of the whole school organization (Walter *et al.* 2005, Slegers and Leithwood 2010, Massel *et al.* 2012).

Both practice-based research and school development are iterative processes (Bauer and Fisher 2007). When practice-based research and school development come together, the term interplay can be used. Interplay between practice-based research and school development can be described as a continuing process, in which the created knowledge from practice-based research provides a better understanding of school practice and strengthens school development, and in which school development is in turn a source for knowledge creation (Levin 2004, Burkhardt 2006). In this study we will concentrate on the impact of research on school development. Such interplay can be called productive in situations in which research is actually used to inform school development. Because practice-based research can consist of multiple cycles, there are several opportunities for feedback from research to school practice (Clow 2012, Grimpe *et al.* 2014). For interplay to be productive, certain conditions are important. One condition mentioned in literature is a rhythm in which the stages of R&D are aligned (Bauer and Fisher 2007, Baumfield and Butterworth 2007). A critical aspect of rhythm is timeliness; research is, for example, timely when results become available at a moment when they are needed to take practical decisions in schools (Oancea and Furlong 2007). Research knowledge can be integrated by practitioners into their practical knowledge and provide them with guidelines for further actions to improve practice (McLaughlin and Black-Hawkins 2004, Van de Ven 2007, Vanderlinde and Van Braak 2010). Several studies indicate that practitioners, through collaboration with researchers, are encouraged to integrate research knowledge into their contextual and local understanding of practice (Cooper *et al.* 2009, Edwards 2012, Janssen *et al.* 2013). However, little insight exists into how research knowledge is actually used in schools (Pareja Roblin *et al.* 2014).

3. Cross-professional collaboration

Important aims of close collaborations between school practitioners and researchers are creating knowledge on school practice and improving school practice. A possible context for such collaboration is professional development schools in, for instance, the United States and the Netherlands in which teacher education programs create a partnership with schools in their region to make arrangements for learning of student-teachers, for induction programs for novel teachers and for supervision of teacher researchers. In these partnerships, teacher educators and school practitioners share responsibility to improve teaching (Trachtman 2007). Another context is in R&D projects in education in which professionals from schools and research and advisory institutes collaborate. These professionals in R&D projects include school practitioners (i.e. school leaders and teachers) as well as researchers, advisers and supervisors from research and advice institutes. In an earlier study we introduced the term cross-professional collaboration, and characterized different types of cross-professional collaboration using the following dimensions: reasons to collaborate; division of tasks and roles; and communication (Schenke *et al.* 2016). School practitioners participate in R&D projects in their school because they want to diagnose, understand and/or solve practical problems in their school, to use research to evaluate an innovation and to share their practice-oriented knowledge and insights with colleagues inside and outside their schools. Researchers have a need to understand practice, deepen their insights and create new knowledge by being involved in (innovative) practice, and connect situated knowledge, school data and research results to knowledge

derived from literature (Coburn and Stein 2010, Ormel *et al.* 2012, McKenney and Reeves 2013).

Collaboration of professionals with different backgrounds and with diverse goals can encourage participants to learn. When teacher researchers and school leaders use knowledge that is derived from a collaborative study this contributes to their own professional development. When they use such knowledge to change practical and conceptual elements in their school this can contribute to school development as well. At the same time, researchers can learn from school practitioners while performing practice-based research; for example because they become aware of the complexity of schools and the sometimes limited relevance of general research findings for specific school practices (Snoek and Moens 2011, Cornelissen *et al.* 2013, Walsh and Backe 2013, Leeman and Wardekker 2014). Important conditions for mutual learning are receptiveness of the professionals towards each other's viewpoint and constant negotiation on the issues of research and school practice (Oancea and Furlong 2007, Edwards 2012). However, this does not necessarily mean that cross-professional collaboration contributes to school development as a matter of course. Such a contribution requires that the results of this collaboration (i.e. research results) are fed back into school practice.

4. This study

As researchers and practitioners move into closer collaboration and generate stronger linkages between them, it is important to understand how these professionals can shape a productive interplay between knowledge derived from practice-based research and changes occurring in school practice. The aim of this study is to obtain a better understanding of how a productive interplay between practice-based research and school development through cross-professional collaboration is established. We examined 19 R&D projects in Dutch secondary schools in which professionals collaboratively carried out R&D activities. The R&D projects were part of a funding scheme that aimed to increase the input of practitioners in research and to improve the use of research for school development by encouraging collaboration. Because the participating schools proposed the research questions for the projects and the approach was thus school led, the funding scheme has characteristics of an inside-out approach (Crossley 2013).

Our research questions are as follows:

1. What types of changes occur in schools that are informed by practice-based research performed in R&D projects in secondary education?
2. How is feedback from practice-based research to school development organized?
3. Which conditions contribute to a productive interplay between practice-based research and school development?

5. Method

5.1 Case studies

This study is set up according to a multi-case study design, including 19 R&D projects in secondary schools in the Netherlands (Yin 2009). The authors of this article

were engaged as overarching researchers and therefore were not involved in carrying out research in any of the projects. The projects received funding for research purposes for one, two or three years, after the funding application was accepted. The funding scheme of the Dutch Council for Secondary Education was intended for projects based on questions posed by a school. The school concerned had to apply for the funding and carried responsibility for the possible transfer of the research budget to a party with research expertise (i.e. universities, universities of applied sciences, teacher education institutes and research and advice bureaus). In every R&D project, professionals developed and studied a program, course or intervention in school practice. For example, one project implemented digital material designed by teachers into their lessons and researchers observed the lessons and tested students' achievement levels. In another project, teachers' pedagogical skills were trained and research results provided information on changes in their classroom behavior. The studies performed in the projects can be defined as practice-based research, because researchers and practitioners were primarily concerned with examining questions and problems situated in the school. The aims of the funding organization were that the research would contribute to school development and would yield knowledge that could be shared in the education field. In this article we will concentrate on the first aim. The article covers the entire three years of the funding scheme.

5.2 *Participants in the study*

The R&D projects involved different professionals: school leaders, teachers, researchers, advisers and supervisors. These professionals were the participants in this study. (Advisers provided school leaders with advice on research and school issues. Supervisors were coaches for teachers who were developing lesson materials and/or performing research in school.) We conducted interviews in four rounds; at the start of the project (round one), at the end of the first year (round two), at the end of the second year (round three) and at the end of the third year of the projects (round four) when the funding of the projects finished. We interviewed 28 school leaders and teachers who functioned as the project manager in their schools, and 23 researchers, advisers and supervisors from educational institutes. In most schools the same professionals were involved in every round, but in one school we interviewed another project manager in rounds two and three. In three projects, other researchers became involved during the process. Extra information on the role of school leaders and of teacher researchers in the projects was acquired by interviewing eight school leaders in the first and final year of the projects, and nine teacher researchers who collected and analyzed data in their school in the third round of interviews.

5.3 *Data collection*

Data for this study were collected through document analysis, semi-structured interviews and observation of meetings. The documentation concerned project applications, progress reports by project managers and final research reports, and reports of small conferences in which experiences were shared between professionals of different projects. The purpose of collecting these documents was to use them as background information in the preparation of the interviews as well as in the analysis of the interviews.

All interviews with the professionals involved in the projects were based on pre-structured interview guidelines. These interview guidelines contained questions about the goals of the R&D project, the progress made in the project, the practice-based research (research goals, type of research, the created knowledge), the occurrence of changes in school (i.e. school development), vision of the participants on practice-based research and school development, and cross-professional collaboration among the professionals in the projects (reasons for collaboration, division of roles and tasks, communication, and perceived successes and barriers). The first author of this article carried out observations of meetings in which professionals shared research results within the project team and meetings in which school colleagues were informed about the progress and results of the projects. The primary aim of the observations was to gain more insight into how feedback of research knowledge was organized.

5.4 Data analysis

The analysis of the data was performed in four phases. At the start of the first phase we operationalized the main elements of this study, as follows:

- Relevant aspects for characterizing the practice-based research were distinguished: type of research, domain on which the research focuses, research results and knowledge derived from the research.
- School development is seen in this study as a continuous process aimed at improving practices in school. School development can become visible in actual changes in school practices. In our analysis we focused on changes that directly resulted from activities conducted in the R&D projects and did not examine indirect changes that may have occurred in the wider school organization stemming from the R&D projects. We made a distinction between conceptual changes (i.e. changes in how certain aspects of school practice are understood) and practical changes in school practice (i.e. concrete, visible changes) (see, for example, Walter *et al.* 2005, Massel *et al.* 2012).
- The interplay between practice-based research and school development is described in this study as a continuing process, in which the created knowledge from practice-based research provides a better understanding of school practice and strengthens school development.
- A productive interplay is referred to as a situation in which practice-based research performed in the R&D project actually informs school development.
- Cross-professional collaboration among professionals in the project is examined in terms of three dimensions: reasons for collaboration in terms of whether there is congruency in the professionals' reasons to collaborate or researchers have additional goals (e.g. commercial interests) division of roles and tasks by characterizing the role of each professional in the project; and communication by focusing on meetings and time investment.
- Conditions for a productive interplay were derived from information about successes and barriers in communication, and division of roles and tasks, as mentioned in interviews and research reports.

In the first phase of data analysis we started by studying the final research reports and progress reports of all 19 projects. We considered the research results per

project, which provided the first insights into the knowledge created in the projects, and the changes in the schools that were described, which provided insights into school development. We then developed a coding scheme based on the literature and our research questions (see Appendix 1). We used MaxQDA (version 10) to code the interview fragments and organized the results in a matrix. Our understandings of observations of project meetings and the document analysis were also included. The outcome of the first phase was a cross-site matrix in which all information on practice-based research, school development and cross-professional collaboration per project was collected. In the rows of the matrix we entered the 19 project codes, and in the columns we entered the corresponding information for each project (Miles and Huberman 1994). For more information on the characteristics of cross-professional collaboration in the R&D projects, refer to Appendix 2.

The next phases were aimed at answering the research questions. In the second phase of the analysis we closely examined the cross-site matrix with a focus on whether or not practical and conceptual changes in school were informed by practice-based research (Research Question 1). The results of this phase made it possible to characterize projects as showing a productive interplay or a less productive interplay between practice-based research and school development.

The third phase of data analysis consisted of analyzing all projects by concentrating on cycles of R&D activities that were observable in the projects. We focused on how research was fed back to inform school development (Research Question 2). This happened mostly by presentations of research results or in meetings with professionals in the project. We examined characteristics of how feedback was provided, such as the frequency of providing feedback of research results, and we organized projects into a matrix to discover similarities and differences in feedback.

The fourth and final analysis provided insight into the conditions under which a productive interplay occurred (Research Question 3). We analyzed what professionals mentioned as successes and barriers in communication and in division of roles and tasks in the projects. We related this information to the results of the second and third phases.

As a form of internal audit, the research team discussed all steps in the process of analysis and its results, and where necessary the primary data were re-checked (Miles and Huberman 1994). As a form of external audit a second researcher, who was not part of the research team but was familiar with the R&D projects, was asked to reconstruct the analysis, judge decisions made by the authors and check the data that were included in a matrix. She specifically checked the characterization by the authors of the interplay in the projects as productive or less productive interplay and of the way in which feedback from research to practice was provided in each project. As an outcome of the dialogue with the second researcher we described more precisely when we characterized a project as showing a productive or less productive interplay, by concentrating on whether or not conceptual and practical changes in a school occurred with the use of research performed in the project.

6. Results

6.1 *Role of practice-based research in occurrence of changes in school*

In this first section, we will focus on the first research question: what types of changes occur in schools that are informed by practice-based research performed in

R&D projects in secondary education? A first finding is that in all 19 R&D projects new knowledge was created by performing research. Knowledge concerned three domains: innovation, teachers' practice and quality of the school organization. In several projects, R&D activities focused on more than one domain. The first domain, innovation in school, mainly concerned the functioning of innovations and their impact on students' learning (students' behavior, motivation or achievement). The second domain, professional development of teachers, involved teachers' activities in classroom, results of participating in a training program and the personal and professional changes of teachers during the project. The third domain, the school organization, was studied by focusing on the quality of the organization, such as evaluations of interventions on a broader school level.

In all domains all kinds of practice-based research were performed, and in some cases more than one kind of research. In 14 of the 19 projects an evaluation study was conducted, and in five projects design research was performed. In two projects the professionals' goal was to design a new instrument and test the validity of the instrument with students' scores, and in two other projects the research goal was to develop and test new instruments on teachers. In two projects an effect study was started, but in only one study was the effect study actually performed. In the other project it was decided to change the effect study into an evaluation study.

Table 1 shows all 19 R&D projects that are included in this study. We ordered the projects into a category of 13 projects with a productive interplay and a category of six projects with a less productive interplay between practice-based research and school development.

6.1.1 Productive interplay

In 13 of the 19 projects research results were actually used to inform school development: a productive interplay between practice-based research and school development. In these 13 projects both practical and conceptual changes were noticed that were informed by practice-based research performed in the project. School leaders and teachers made decisions about changes in a program, training or innovation, based on information from, for instance, a literature study, research results or data from questionnaires or interviews.

Practical changes in practice, which were informed by research, involved adjustments in elements of an innovation, a course, training or a program. A good example of practical changes informed by research can be found in Project H. In this project, teacher researchers analyzed the latest literature on teaching literacy and conducted an evaluation study of their lessons. By integrating academic knowledge and research results into their practical knowledge, these teachers were able to improve their lessons. They implemented new literacy approaches such as observational learning and a special approach for motivating boys to read fiction.

Another example can be found in Project M in which the school leaders decided to open up a training program to more teachers, when interviews with students of the first group of teachers who followed the training program revealed a positive result for these students. During the training, teachers learned techniques for providing feedback on the learning process of their students. It was launched to enhance students' grades and improve relationships between teachers and students. The project manager, in this case the school leader, also based her decision to focus on feedback techniques in the higher classes on research:

Table 1. Interplay between practice-based research and school development in 19 R&D projects in schools.

School development and research	Productive interplay between practice-based research and school development										Less productive interplay between practice-based research and school development									
	Short-term feedback loops					Long-term feedback loops					Short-term feedback loops					Long-term feedback loops				
	Project B	Project X	Project E	Project D	Project H	Project I	Project C	Project O	Project J	Project L	Project M	Project Q	Project S	Project R	Project A	Project N	Project F	Project G	Project K	Project P
Innovation: students' behavior, motivation or achievement	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-
Teachers' professional development	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
School organization: quality of organization	-	-	-	-	-	X	-	X	X	X	X	-	-	-	-	-	-	-	-	-
Design research	-	-	-	-	X	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-
Evaluation research	X	X	X	X	X	X	X	X	X	X	X	-	-	X	X	X	X	X	X	X
Effect research	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
Develop an instrument	-	-	-	-	-	X	-	-	-	-	X	-	-	-	X	-	X	-	-	-
Congruent reasons of professionals	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Additional reasons of researcher	-	-	-	-	-	-	-	-	-	-	X	X	X	X	-	-	-	-	-	-
Teacher researchers	X	X	X	X	X	X	X	X	X	X	-	-	-	X	X	X	-	X	-	-
School leaders, project managers	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Weekly meetings	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Monthly meetings	-	-	-	X	-	-	X	-	X	X	X	X	X	X	-	-	-	-	-	-
Two or three times a year a meeting	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X

Note: X, as observed in the project; -, less changes in school occurred that were informed by research.

Based upon a study on our exam protocol and the use of it [by teachers] ... we concluded that one of the most important instruments to enhance grades [of students], to increase the standard, to make better tests, is the use of feedback techniques in the classroom. (Interview, school leader, Project M)

She informed one of her new team leaders about the results of the research and recommended stimulating teachers in his team to integrate feedback techniques into their classroom:

... based upon the results of the project we gave it a try in the higher classes. We have a new team leader who will start at that position next school year ... We recommended him to make use of the content evaluation of the exam protocol and of the results of the feedback cycle, to make arrangements [with the teachers] on outcomes next year. (Interview, school leader, Project M)

School development can be traced by practical changes, but also by detecting conceptual changes in practice. A noticeable conceptual change in practice in all 13 projects was that professionals expressed a better understanding of the main issue in their project with the use of research. New knowledge was considered and adapted in their conception of the innovation, professional development program or school organization. The knowledge derived from research and the experiences and results that it provided offered school practitioners, for instance, arguments to consolidate an innovation. The school leader of Project S pointed out:

The difference with previous innovations in our school is that we connect research to an innovation these days. I consider that as the strength of this project. A former pitfall of ours was to constantly innovate which lead to reinventing the wheel over and over again. We did not consolidate adequately and best practices were lost. Nowadays, our school board expresses the need to examine innovations in our school. (Interview, school leader, Project S)

6.1.2 *Less productive interplay*

A less productive interplay between practice-based research and school development was detected in six of the 19 projects (see Table 1). Although these six projects produced research results, school leaders and teachers did not use research to create a better understanding of school issues (i.e. conceptual changes) or to inform decisions on practical changes in school. The school practitioners in the six projects put effort into school development: they were stimulating innovations in school, professional development programs for teachers or changes at the organizational level. However, these efforts in school development were not aligned with research performed in the project. For instance, in Project G a personnel change in the school board halfway through the project caused a mismatch in project goals between the researchers and the new school leader. The researchers' goal was to develop an instrument to measure the reading level of students and to return results after thorough analysis. The new school leader was expecting her teachers to reflect on individual students' results derived from the research. However, the results did not arrive during the school year, but at the beginning of the next school year when the teachers already had other students. Miscommunication between researchers and school leader and a lack of timeliness resulted in a less productive interplay in this project.

6.2 *Feedback in the R&D projects*

In this section the second research question is answered: how is feedback from practice-based research to school development organized? The projects contained several, iterative cycles of R&D with corresponding possibilities to make a connection between practice-based research and school development. For example, when research results were available, a presentation was given to inform practitioners' decisions on school issues. Two kinds of feedback loops were identified: short-term feedback loops in 12 projects and long-term feedback loops in seven projects. The feedback loops show no direct cohesion with a productive or a less productive interplay (see Table 1).

6.2.1 *Short-term feedback loops*

Short-term feedback loops, found in 12 projects, provided the opportunity for professionals to quickly adjust a program or intervention. During the school year, feedback of research results by researchers and teacher researchers was provided regularly. Professionals met each other in frequent meetings once a month, or even created a professional learning community in which they worked together in weekly meetings. The cross-professional collaboration in these projects is further characterized by congruent reasons for performing the research; professionals jointly agreed on the purpose of the research, which was derived from questions posed by the schools.

In Project B one of the school leaders instigated the use of mind maps with teachers. A monitor was introduced to follow the use of mind maps in science lessons. An effect study was set up to measure students' science achievement. However, the project team decided to postpone certain components of the effect study and change it into an evaluation study. This evaluation study matched the needs of the school board and teachers who required research results during the school year. Consequently, the project team now had access to knowledge that came from test results in science and interviews with students throughout the year. They were challenged to alter elements of the innovation during the year, as the supervisor explained:

These results are very interesting and it absolutely provides us with strengths and weaknesses on how to introduce mind maps in school. Next year, the idea is to make use of shorter feedback loops, ... question students more often on what their opinion is on how it works. When it becomes clear to us that the program [on mind maps] is fully developed ... than the time is right to measure again in terms of students' achievement and motivation. (Interview, supervisor, Project B)

In Project D several interventions had been set up to create a smooth transition for students moving from elementary school to secondary school, which was situated in a larger school building with more students. One of the interventions aimed at teachers and their influence on student motivation and classroom climate. The researcher in this project constructed a questionnaire on these topics. The results were evaluated during a meeting with parents and teachers and also in smaller groups of teachers in the different participating schools. Two project managers who were school leaders in two different schools ran these meetings. One of the project managers reflected on the process:

Recently this questionnaire is filled in for the second time. In the first round we noted differences between the elementary schools and a difference between the elementary schools and secondary school regarding the options students have in their program. We draw some first conclusions with the goal to see in the second round of questionnaires if there is a change in the course of the year [concerning the classroom climate]. ... We do expect to see a dip in motivation when students go to secondary education. (Interview, school leader, Project D)

After the results of the second round in Project D were available, the project managers and teachers discussed the results and decided to pay more time and attention to the motivation of the students in the mentoring program. The short-term feedback loops in this project provided the project managers with new information during the school year. They not only used this information to check whether their innovation was on the right track, but also used the data to encourage colleagues to change their practice in order to motivate their students.

6.2.2 Long-term feedback loops

In the seven projects with long-term feedback loops, professionals mostly met each other two or three times a year, with a prominent position for the final meeting of the year in which research results were presented. This meeting was in all cases with a larger group of school practitioners (e.g. all teachers teaching a certain grade or subject) and was meant for sharing research results. Professionals mentioned several elements that they considered important in communication, such as expressing expectations to each other, making agreements on tasks and schedule, and paying attention to both informal and digital communication means. In three of the seven projects the external researcher brought along additional reasons next to paying attention to school questions and school issues (see Table 1). These concerned collecting data for academic purposes or developing a literacy instrument for commercial reasons. The roles and tasks in these projects were more traditionally divided: researchers had the main responsibility for formulating research questions, and collecting and analyzing the data, while teachers and school leaders typically participated in this research as respondents.

In Project R, teachers started with a training program on how to observe each other in lessons in order to improve their teaching skills. After observing colleagues in their lessons and filling in observation instruments, which were developed by the researchers, the results showed changes in the teachers' teaching practice. The presentation of the researcher at the end of the project showed the teachers these results and they were encouraged to keep working on improving their teaching skills.

6.3 Conditions for a productive interplay

In this final section we will answer the third research question: which conditions in R&D projects contribute to a productive interplay between practice-based research and school development?

6.3.1 Conditions in projects with short-term feedback loops and a productive interplay

In 10 out of the 13 projects with a productive interplay, the projects contained short-term feedback loops.

A first condition in these projects was the ability of the professionals to respond adaptively to new research results. The school practitioners and researchers had timeliness in mind: research results became available at a moment when they were needed in school. Actually, these professionals were closing the feedback loop; the closing was mainly done by the school practitioners, but based on input of the researchers. In other words: in these 10 projects the rhythms of practice-based research and school development were aligned. This is a main difference with the three projects that also contained short-term feedback loops but had a less productive interplay.

Project I is an example of a project in which professionals showed adaptive responses. The researcher involved in Project I expressed that she and the project manager learned from experiences and from the knowledge derived from research results in the first year. They decided to change parts of the program of the teacher training in the second year and to include school leaders as coaches in the project to increase their involvement with the teachers' development. The researcher explained how these adjustments were supposed to influence the teachers:

It will have an impact on how this teacher will feel supported by the school board. ... We have said we like this to be more structured next year. We also want to go back to two meetings every month on Wednesday. In one meeting we will put emphasis on peer supervision, by bringing together two teachers with two other teachers that work in a different school location. The school leader will function as their coach. So, the noncommittal atmosphere we had this year will disappear ... In the other meeting we will preserve the same character as it was this year, explicitly focused on sharing knowledge [between the teachers]. (Interview, researcher, Project I)

A second condition in these projects concerns the ability to tune in with other professionals. Tuning-in may have been facilitated by the monthly or weekly meetings or the formation of a kind of professional learning community that was seen in several of these projects. Cross-professional collaboration provided the opportunity to extensively exchange ideas about practice-based research and school issues. For example, in Project I the researcher had to fine-tune ideas and plans with the teachers and project manager during the first year. She stated:

Sometimes we had a disagreement on the content, we saw things differently. But actually we always resolved the arguments. It has to do with your background, your other vision, but not that it clashes. (Interview, researcher, Project I)

A third condition was sharing and discussing knowledge and skills in the project, especially found in projects with short-term feedback loops in which professionals invested a medium or high amount of time in the project. This condition contributed to a better and deeper understanding of each other and the work of the other. For instance, in Project E the professionals showed changes in their understanding of the terminology they used in the project. They decided to no longer use the label of highly gifted students, but focused on the term gifted students and their underachievement. When asked about his knowledge on gifted students after finishing the literature study and having discussions on the core concepts in the project, the school leader explained:

Yes, it is like inside a ball from which you can pull out all kinds of strings. Concerning gifted students and their achievement, it has become an aspect of which we have a better insight in what is happening. ... However we are not there yet, I mean it is the start of a new beginning, but we sense this is an important result. (Interview, school leader, Project E)

He reflected on the process of sharing and discussing new knowledge, based upon a better understanding of literature:

It felt like a very interesting process, because, well it is not about highly gifted students and not about underachievement of students. Underachievement is not a very sharp defined term, therefore we had very nice discussions on this label, such as what are characteristics based upon literature and how should we compose the group [of gifted students]. We did a good job with combining the different characteristics we derived from literature. (Interview, school leader, Project E)

6.3.2 Conditions in projects with long-term feedback loops and a productive interplay

In three projects (Projects Q, R and S) with long-term feedback loops, conditions were available that led to a productive interplay.

A first condition entails professionals who are making agreements for meetings and division of roles and tasks, right from the start of the project. These kinds of agreements were missing in the other projects with long-term feedback loops.

A second condition was the ability of these researchers to translate the research results to the practitioners. This was usually done in a presentation at the end of the school year and can be seen as a way of closing the feedback loop. In Projects R and S the researchers presented the results, including tables in which the data were shown. This condition was also observed in Project Q, but differs because the translation of research results to school practitioners was done by one of the school leaders. In this project a central aim was to obtain insight into the functioning of the instrument for testing students' achievement in reading. The school leader had a background as a mathematician and was able to read the complex data correctly, which provided him and his colleagues with new insights:

Well, a part of the interpretation is of course written down in the report and there are also drawn some conclusions. But we have simply spoken on what we see that is happening between our weakest students and better students. We have observed that a gymnasium-student in general performs a little less high than an atheneum-student in the subject of reading texts. And if we dig in deeper into the results, than it becomes clear that we have a lot of students on gymnasium-level who perform less than they could. (Interview, school leader, Project Q)

A third condition in these three projects was found on the side of the school practitioners. They had a vital task in interpreting the data and knowledge that was derived from research performed in the project and connecting these to their own school practice. The school leader assisted his colleagues in the interpretation of the research results. In the three projects this resulted primarily in practical changes in school. For instance, in Project Q a practical change concerned introducing a more suitable text as part of a new version of the literacy instrument. They also made decisions on the basis of the data that came from the research; for instance to integrate special reading lessons into the weekly curriculum and to continue measuring

the improvement in literacy after the project was finished by using the instrument developed in the project.

7. Conclusion and discussion

In this study we explored how a productive interplay between practice-based research and school development through cross-professional collaboration is established in 19 R&D projects. A productive interplay, in which practice-based research informed school development, was found in 13 of the 19 projects. Practical changes in schools involved alterations in aspects of an innovation, course or program. Conceptual changes concerned a better understanding by the professionals of the issues on which research was conducted.

Secondly, we examined how feedback from practice-based research to school development was organized in the projects. We distinguished between short-term and long-term feedback loops. Short-term feedback loops occurred when professionals met each other in frequent meetings. Such feedback loops encouraged professionals to quickly adjust a program or intervention in school via an iterative process of practice-based research and school development. Long-term feedback loops occurred when professionals involved in the project met each other two or three times a year. We found that in these projects the end meeting of the year was a prominent element in closing the feedback loop.

Finally, we focused on the conditions contributing to a productive interplay between practice-based research and school development. In the 10 projects with a productive interplay and short-term feedback loops, the professionals shared expectations, jointly agreed on the purpose of the research and had frequent meetings. During the school year feedback of research results by researchers and teacher researchers was provided regularly. Research results were shared and gave rise to discussions with each other. These conditions encouraged the emergence of a professional learning community of which the professionals from both school practice and academic field were part. These professionals succeeded to tune in to other professionals and both practitioners and researchers responded adaptively to (new) research knowledge. In the three projects with long-term feedback loops and a productive interplay, it proved important for professionals to translate and interpret research results, and to make arrangements on meetings and division of roles and tasks. Some conditions prevailed in projects with short-term feedback loops and others in projects with long-term feedback loops. The most important condition in both kinds of projects with a productive interplay was the attention paid to closing the feedback loop: in these cases, research results informed decisions taken on practical and conceptual changes in school.

The results of our study lead to the conclusion that R&D projects provided conditions for professionals to create an iterative process, in which knowledge from research was often used to inform decisions about school practice during the school year. These findings match with the so-called loop script which Bauer and Fisher (2007) presented, in which 'research draws its inspiration from practice and feeds the results back' (2007, p. 228). The rhythm of practice-based research coincided with the rhythm of school development. Researchers and school practitioners were aware of the importance of timeliness and were able to translate practice-based research to school practice. Oancea and Furlong (2007) mentioned these as important features of practice-based research. The results of this study contribute to the

literature on inquiry-based working in schools. School leaders and teachers in two-thirds of the R&D projects appeared to generate a better understanding of their practice with the insights they obtain using research results. School leaders and teachers were particularly encouraged to take decisions informed by research performed in the projects in which practice-based research was finely attuned to school practice and in which they shared expectations and made agreements on project goals (Walter *et al.* 2005, Earl and Katz 2006, Oancea and Furlong 2007, Trachtman 2007). Our study also provides insights into how future cross-professional collaboration can be shaped, for instance on the issues of providing feedback, arranging meetings and sharing purposes of research (McLaughlin and Black-Hawkins 2004, Nutley *et al.* 2008, Ormel *et al.* 2012).

7.1 Limitations and suggestions for future research

A first limitation concerns the funding scheme, which aimed to encourage the exchange of knowledge between the academic field and school practice in the projects. This scheme may have influenced the professionals to share more knowledge and in different ways than might be the case in other settings in which researchers and practitioners collaborate. Future studies on the interplay between practice-based research and school development in contexts other than funded R&D projects may clarify whether the same conditions prevail. Secondly, our analysis is limited in that we have emphasized the interplay as moving in one direction, namely from practice-based research to school development. Research into how the cycle of school development to research works out would be a relevant next step. A third limitation is that characteristics of schools and research institutes may also have an influence on the interplay between practice-based research and school development. Some information on these characteristics was provided in interviews and in reports, but in future studies on professionals in R&D projects it will be relevant to integrate more questions concerning the conditions in the context of the projects.

7.2 Implications of this study

The way in which the R&D projects were set up provided the professionals with an opportunity to collaboratively work on joint goals relevant for both parties. Although characteristics of cross-professional collaboration among the professionals differed between the projects, in general our results suggest that it is important for a productive interplay to be aware of closing the feedback loops to ensure that changes in schools are actually informed by research results. On the one hand, closing the feedback loop requires researchers, advisers and supervisors to deepen their insight into, for example, school plans and goals in order to acquire a good perspective of school issues. On the other hand, closing the feedback loop requires teachers and school leaders to use and interpret research to inform their school practice and introduce practical and conceptual changes in their school, which in turn must be monitored and evaluated, and can give rise to new questions.

Research funding that is in line with the characteristics of the inside-out approach (Crossley 2013) allows professionals from schools and research institutes to meet more often and develop a better understanding of each other's purposes with research in school. Our study shows a high number of professionals who grasped the opportunity to share new knowledge and research results on innovations, teaching

practice and organizational changes, and actually used research to inform school development. Important conditions appeared to be making clear agreements on meetings and on research goals, as well as focusing on closing the feedback loop by sharing and discussing research results. As researchers and practitioners paid attention to these conditions, they created situations in which research results informed changes in school practice.

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Appendix 1. Coding scheme, used for analyzing interviews.

Code	Explanation
R&D project team	
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 project participants in case of changes in project team
Project activities and output	
Development activities	Progress in project activities on level of development and opinion on this issue; with attention to, for example, an innovation, professional development of teachers
Research activities	Progress in project activities on level of research and opinion on this issue; with attention to, for example, tests, questionnaires, analysis and reports
Role of research in the project	Role of research in the project, for instance informing school development, and opinion on this issue
Output work floor	Output visible on the work floor for colleagues and students
Output organization	Output on the organizational level; new structures and routines
Ideological output	Output on ideological level; changes in thinking; what is learned
Reached goals	Goals reached for research and development
Embedding research in school	
Conditions	Conditions on personal, material and financial levels
Support in school	Support of employees for research and development project; creation of support
Internal knowledge dissemination	Internal knowledge dissemination and contribution to school development
External knowledge dissemination	External knowledge dissemination and contribution to accountability
Permanent place in school	Ways of ensuring research to obtain a permanent place in school organization
School leader's 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)

(Continued)

Appendix 1. (Continued).

Code	Explanation
Vision of institute	Vision of school/institute on performing practice-based research in school; support on performing research
Cross-professional collaboration	
<i>Reasons for collaboration in project</i>	
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
<i>Division of roles and tasks in project</i>	
Role of school leader	Role, tasks, actions undertaken and responsibilities of school leader in research and development
Role of project manager	Role, tasks, actions undertaken and responsibilities of project manager in research and development
Role researcher/adviser/ supervisor	Role, tasks, actions undertaken and responsibilities of researcher, adviser or 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
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, telephone
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
Plans and expectations	
Continuation of school development	To what extent is school development, for instance an innovation or program, continued next school year? Plans and expectations
Continuation of research in school	To what extent is research in school, for instance research engagement, teacher research, continued next school year? Plans and expectations
Continuation of cross-professional collaboration	To what extent is cross-professional collaboration between research institute-school continued next school year? Plans and expectations

Appendix 2. Characteristics of cross-professional collaboration in R&D projects.

		Division of roles and tasks and communication							
		Direction and guidance			Role in research and time investment				
Project code	Reasons for collaboration	Development	Research	School leader	Time investment	Teacher researcher	Time investment	External party	Time investment
Projects A, B, C, D, E, F, G	Congruent	School	School and external party	Project manager	High	Present	High	Project manager, researcher, supervisor	High, sometimes low
Projects H, I, J, K, L, M	Congruent	School and external party	School and external party	Project manager	High	Present	High	Project manager, researcher, adviser, supervisor	High
Projects N, O, P	Congruent	School and external party	School and external party	Project manager	Low	Not present	Low	Project manager, researcher, adviser, supervisor	High
Projects Q, R, S	Additional	School and external party	External party	Attune to development	Average	Present	Low to average	Project manager, researcher, adviser, supervisor	Average to high