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RESEARCH

Conditions for the Active Involvement of Teachers in a Design-Based Research Project

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Design-based research (DBR) develops solutions in combination with research and has gained increasing popularity in educational research. This research approach involves close collaboration between researchers and practitioners. Many studies show that teachers are often passive participants in DBR projects, where their role becomes implementing researchers' ideas. This paper reports on a case where teachers became, instead, a driving force in a DBR project and investigates the conditions for this to happen. Data were collected by means of group interviews with the eight pilot teachers in the KreTek project, which was undertaken as a collaboration between a university and a municipality in Norway. The authors' own experiences as participants in the project also form part of the empirical basis for the study. The conditions for active involvement identified here are 1. A shared and relevant challenge; 2. An open entrance to the project; 3. An allocated time and meeting space; and 4. Responsibility and autonomy. The results are discussed in light of perspectives on teacher professionalism, theories on self-determination and previous research on teachers' roles in collaboration between researchers and teachers. It is concluded that by fulfilling the identified conditions for active involvement of teachers with an emphasis on trust, responsibility and autonomy, teachers may play an active role in DBR projects. In turn, this can facilitate a fruitful process where products of research projects using a DBR approach are deeply grounded in practitioners' contexts and thus are able to meet the actual needs of schools.

Keywords: design-based research; teachers; communities of practice; professional learning communities; teacher professionalism; teacher-researcher collaboration

Introduction

Design-based research (DBR) is a methodology where development and research are combined with the aim of establishing theoretical insights and educational innovations that are usable in a wider context (Anderson & Shattuck, 2012). It is regarded as a constructive approach for educational research, as collaboration between researchers and practitioners is meant to ensure results that are deeply embedded in teachers' practice. This way, DBR may bridge what is referred to as a research-practice gap in educational research (see e.g., Anderson & Shattuck, 2012; Bogaerds-Hazenberg, Evers-Vermeul, & van den Bergh, 2019; Goos, 2014). Anderson and Shattuck (2012) point to situatedness in real educational contexts and collaborative partnership between researchers and practitioners as the main characteristics of DBR. Many have, however, observed that teachers are not as active in DBR projects as intended (Andrée, Danckwardt-Lilliestrom, & Wiblom, 2020; Engeström, 2011; Sterner, 2019). Rather than involving collaborative partnerships, projects tend to be strongly framed by researchers' ideas, while the role of the participating teachers is limited to the implementation and refinement of predefined solutions. This may lead to a lack of contextual sensitivity and limited value of the products of the research process.

In this paper, we draw on an empirical case that has been successful in terms of engaging teachers actively in a DBR project and explore the reasons why this was achieved. What key conditions can be identified for active involvement of teachers from this case?

The investigated case is the KreTek project, which seeks to realise the intentions of the ongoing curriculum reform for compulsory education in Norway (NDET, 2020). This is done by developing teaching designs that include creativity in science and mathematics teaching in combination with digital technology—in particular, programming. Eight teachers from four lower secondary schools collaborated with researchers and technology experts from a university. In contrast to what is often the case in DBR projects, the group of participating teachers in KreTek turned out to be a driving force in the development of the project. Based on interviews with the teachers as well as the experiences and interpretations of the researchers involved, we identify features of the project that have been important for the active role the teachers took. The project thus serves as a case to identify conditions for active teacher involvement that have been important in this particular context

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and that may have broader relevance. Results are analysed in light of perspectives on communities of practice and professional learning communities and compared to previous research that reports on the role of teachers in DBR projects. Finally, we discuss how participation in a DBR project may contribute to teacher professionalisation.

Teachers' role in design-based research

DBR is described as the development of educational innovations in several cycles in collaboration between researchers and practitioners in order to produce solutions as well as generalised knowledge of relevance beyond the context where the development is conducted (Anderson & Shattuck, 2012). Based on Nieveen (1999), Plomp (2007) formulates criteria for high-quality interventions in order to achieve generalised knowledge of value for practitioners. These criteria are relevance (also referred to as content validity), consistency (also referred to as construct validity), practicality and effectiveness. Relevance and consistency imply that the developed design is based on state-of-the-art (scientific) knowledge and that the intervention is 'logically' designed, respectively. According to Plomp (2007), practicality means that "teachers (or, more generally, representatives of the target group of users) consider the intervention to be usable and that it is easy for them to use the intervention in a way that is largely compatible with the developers' intentions" (p. 28). Effectiveness means that the intervention actually results in the desired outcome.

The role of teachers is crucial in DBR, and some research studies therefore describe teachers as 'actors' or 'co-designers' (see e.g. Bogaerds-Hazenberg et al., 2019; Konrad & Bakker, 2018; Sterner, 2019). This is to signal a contrast to intervention studies and design experiments where teachers merely have the role of implementing researchers' ideas without ownership of the innovation.

This crucial role of the teachers is acknowledged in how Juuti, Lavonen, and Meisalo (2016) present a pragmatic approach to DBR in education, involving a close relation to the educational context. This means that researchers and teachers engage in a shared activity with joint goals in the design of the innovation, taking contextual factors into account. Effort must be put into meaningful communication with intended users outside the research context for the innovation to have a more general value. They describe the starting point of the DBR process as a situation where neither researchers nor teachers know how to act. This is somewhat in contrast to the quality criteria described by Plomp (2007) and referred to in the foregoing, where 'developers' and 'users' are described as different groups in intervention research.

Engeström (2011) pinpoints this difference when describing *formative interventions* as an alternative to traditional experimental designs and design experiments. He claims that design experiments share the basic linear methodology of traditional randomised trials and ignore the resistance and agency of participants in the experiment:

> In discourse on 'design experiments', it seems to be tacitly assumed that researchers make the grand design, teachers implement it (and contribute to its modification), and students learn better as a result. Scholars do not usually ask: Who does the design and why?
>
> (p. 600)

In contrast, the concept of formative interventions takes into account that interventions into human beings' activities are met with actors with identities and agency, not with anonymous mechanical responses (Engeström, 2011, p. 603). Engeström points to four crucial ways in which formative interventions differ from design experiments: (i) The starting point is a problem embedded in participants' activity, where the solution is not known to the researchers; (ii) The content and course of the intervention is not predefined but negotiated, and the participants are in charge of the process; (iii) The outcome is not a standardised solution but new concepts that function as frames for locally appropriate solutions; and (iv) The role of the researcher is not to control variables but to provoke and sustain a transformation process led and owned by the participants (ibid.).

Building on the symmetry principle formulated by Sensevy, Forest, Quilio, and Morales (2013), Andrée et al. (2020) show how a lack of symmetry may be due to different values held by participants. These values are embedded in the collaboration with regard to the changes the work seeks to achieve, the social relations between participants, who is credited and held accountable for results and what counts as evidence and for what purpose. The researchers describe how they found themselves trapped in the "researcher as 'thinker', teacher as 'doer'" dualism in their work with teachers, even if they had an egalitarian approach to the collaboration.

Bogaerds-Hazenberg et al. (2019) question the feasibility of equal participation of teachers and researchers. They point to challenges in teachers' lack of pedagogical content knowledge and the fact that teachers and researchers may hold different values and beliefs.

Goos (2014) also argues that researchers and teachers are members of separate communities of practice that create and value different types of knowledge. It is essential for the research collaboration to account for how teachers enter the research process, what the purpose is and how meanings are negotiated. She describes how 'boundary encounters', that is, events that give members of one community of practice a sense of how meaning is negotiated within another practice, may contribute to connecting communities and thus coordinate perspectives or generate new perspectives of value for the research process.

In sum, the perspectives and research results presented above show that the researcher-practitioner collaboration, as an essential feature of DBR, may be difficult to realise and relate to the participants' agency, knowledge, values, perceived roles, and professional identities. The section to follow reviews teacher competence from the perspective of professionalism.

Teacher competence and teacher professionalism

Development of teacher competence and empowerment is linked to seeing teaching as a profession. A profession

is generally associated with autonomy and a professional knowledge base. For example, Klette (2000) has described a profession as characterised by a specialised knowledge base, a service ethic, a professional commitment and a collegial (as opposed to bureaucratic) control over practice and profession. However, teaching is, globally, increasingly associated with performance measurement and externally defined criteria of quality, leading to a view of teachers as 'technicians' rather than members of a professional community (Day, 2017). In a comprehensive study run by OECD, Schleicher (2018) presents an analysis of what characterises high-performing schools. He points to how many top-down initiatives are unsuccessful in achieving change in schools because their focus is too distant from the core of teaching and learning, because reforms assumed that teachers would know how to do things they actually did not know how to do, because reforms had too many agendas or simply because schools and teachers did not buy into the reform strategy (p. 97). Successful policy implementation requires instead that the knowledge and experience of teachers and school leaders is mobilised, since these are the people who can make the practical connections between the classroom and the changes taking place on the outside (Schleicher, 2018, p. 207). In the case of digital programming in the curriculum in general education, a recent study by Vinnervik (2020) exhibits how the Swedish school reform leaves teachers with a feeling of uncertainty and unpreparedness. Vinnervik suggests that this is due to how the process from decision to implementation has been forced at policy levels of the educational system.

In a comprehensive Delphi study of ambitious technology and engineering teachers, Rose, Shumway, Carter, and Brown (2015) formulated five core teacher competencies. The first three categories mirror the classical categories of teacher knowledge in Shulman (1986) that are relevant for classroom work (content knowledge, pedagogical content knowledge and curricular knowledge), In addition, the set of categories also includes *interpersonal competence* and *professional competence.* Interpersonal competence relates to collaboration in the school, and professional competence includes abilities to influence others and contribute to the advancement of the profession. The latter seems to be somewhat neglected in discussions of school development and teacher collaboration, where knowledge and autonomy are seen as features of the individual teacher or locally at the school (see e.g. Kelchtermans, 2006; Little, 1990). At the collective level of a profession, it implies that teachers, as representatives of the profession, take and are given the responsibility and autonomy to advance and disseminate knowledge and good practices.

Schleicher (2018) points to how teachers rarely work in the collaborative work culture that is taken for granted in other knowledge-based professions. The concept of *professional learning communities* (see Hargreaves, 2019; Hord, 1997) has evolved to describe how teachers and other professionals may learn in a collective manner and, in this way, advance the knowledge base of the profession. Based on a comprehensive empirical study with a focus on teacher agency, Brodie (2019) identified key features of professional learning communities: a clear and shared focus that teachers find useful and that provides for interesting and challenging discussions; a shared agency in the collaboration; support from school leadership; time for long-term inquiry; and mutual trust in the group of collaborators. These features are also relevant for collaboration in a design-based research project, where teachers participate in educational innovations.

Research context: Meeting challenges in a new curriculum

The KreTek project evolved from needs created by a curricular reform in Norwegian schools (NDET, 2020). The new curricula in the reform emphasise creativity, inquiry and the development of innovative skills. One of the core values is formulated as, *"Schools shall allow the pupils to experience the joy of creating, engagement and the urge to explore, and allow them to experience seeing opportunities and transforming ideas into practical action"*. Further, in-depth learning is emphasised in all subjects, and programming forms part of the curricula for several subjects. For example, in mathematics in lower secondary school, students are to explore mathematical properties and relationships by means of programming. In lower secondary science, students are to explore, understand and make technological systems that consist of a transmitter and a receiver and use programming to explore natural phenomena. This clearly represents a challenge for teachers. Many teachers lack skills in programming, as it is a new subject where learning targets are not well defined and where teachers are not given clear directions for what and how to teach (see Vinnervik, 2020 in the case of Sweden).

The KreTek project set out to meet these challenges through a design-based research approach. Development is undertaken in a collaboration between a group of teachers and researchers with the purpose of developing resources of value for schools and teachers more generally. The project is a collaboration between a local municipality and a university with joint management and support from the Research Council of Norway. The project aims to develop and test teaching designs that combine in-depth learning in science and mathematics in lower secondary schools with students' creativity and programming skills. Further, it aims at developing a model for assessment that takes students' creativity into account and collaboration structures between schools and teachers.

These broad aims were formulated by the research group in collaboration with the coordinator from the municipality in light of challenges in the new curriculum and ahead of recruitment of teachers. The subsequent development of the project had a pragmatic approach, as described by Juuti et al. (2016), and involved close attention to contextual factors for the innovations. Eight pilot teachers were recruited from four schools. Schools were selected based on their application for participation after announcement from the municipality as school owner, and a coordinator from the municipality participated actively in developing and running the project. Participants from the university were science education researchers, teacher educators in science and mathematics, and technology experts

from departments of information technology, electronic systems and design. A total of 11 participants from the university were involved in the project, but not all participated in all meetings. This meant that the teachers were often a majority in project meetings.

All the pilot teachers were teaching science and/or mathematics. Some had experience with programming, but only one had been teaching programming. One had a background in arts and crafts, and some had rich experiences in experimenting with digital as well as more traditional technology, such as construction.

Support from the Research Council of Norway provided for the group of pilot teachers to be free of teaching a half day every week. The project coordinator at the municipality ensured that all eight teachers were free of teaching *at the same time* in the week, so the allocated time could be used for meetings and collaboration.

The meetings during the first year of the project mostly contained teachers' work on developing teaching designs, mainly in smaller groups across schools. The start-up was very open: the challenges in the curriculum were discussed, and some small, simple activities with electricity kits were arranged in order to establish a safe atmosphere where all teachers felt confident. Ideas for development were encouraged from the teachers, but not until the third meeting did they come up with ideas for what they wanted to develop. From there, they took a very active role and managed their work in energetic ways. The atmosphere developed so participants could be supportive, joyful and respectful of each other's competence, with an eagerness to learn from each other. Meetings have also contained contributions from experts on programming, creativity and video documentation, as well as a visit to a local science centre that offers a maker space for schoolchildren and teachers. This program was planned by the project leader from the university in collaboration with the pilot teachers. The science and mathematics educators from the university acted as sparring partners in the development, while the university technology experts took a more peripheral role in the project but were actively consulted by the pilot teachers when they needed technical help.

The second year was dominated by testing of the developed products in classrooms and therefore had fewer project meetings. The teachers have kept up the active role, contacting each other across schools on their own initiative and showing willingness to try out teaching designs other than the ones they had planned. This indicates that the teachers had joint ownership of the products of the project and felt secure about testing them in their own classrooms with members of the research group present with cameras and recorders. A development in self-confidence can be seen in how some teachers who, at the outset of the project, showed some reluctance towards having their classroom filmed seemed to have no problems with this after a year in the project. The same teachers also held an online course for other teachers after less than a year.

The third and final year will involve further trials in schools and communication to other teachers as well as data analysis undertaken by the research groups.

Research methods: Data collection and analysis

The empirical basis for this study is group interviews with the teachers participating in KreTek, but it also includes the experiences and interpretations of the researchers involved. Research on a process where one is an active participant clearly has challenges when it comes to trustworthiness. However, as elaborated in depth by, e.g., Blair (2015), qualitative analysis is always a subjective and interpretive process undertaken with a certain perspective and with certain contextual insights and assumptions. In the study reported in this paper, preconceptions about the situation under investigation represent a starting point of the research process rather than subjective assumptions to be avoided. This is in line with how Braun and Clarke (2020) point to the researcher's subjectivity as an *analytic resource* in a research process, where transparency and reflexive engagement with theory, data and interpretation are important. This view of subjectivity as an analytic resource makes it reasonable to include researchers' personal experiences, reflections and interpretations as part of the empirical basis of a study and represents one of the steps in the analytic process of this study.

The more formal data in this study consist of group interviews with the eight participating teachers in the KreTek project. They were undertaken with informed consent, and the project as a whole was approved by the Norwegian Centre for Research Data. Three rounds of group interviews were conducted during the first year of the project period, with four teachers in each group. The composition of participants was altered each time to expose as many viewpoints as possible. The first interview round was undertaken at the very start of the project and focused on creativity—what it is and how it can be fostered in schools. The second interview round was undertaken halfway through the first year and focused on collaboration and development of competence by participating in the project. The focus of the third interview round, undertaken after 1.5 years, was on the assessment of creative skills. This paper mainly draws on data collected in the second round, and quotations given in the presentation of results are all from these two group interviews.

The interviews were undertaken by members of the research group. This might be a challenge to the validity of the results since the teachers might like to give answers that please the project leader in particular. However, we found that the views articulated in the interviews were much in line with what we, as researchers, had experienced. We also saw that the teachers at some points challenged the anticipations in interview questions and that there was also acceptance of disagreement between the teachers. Incidences of this kind were more frequent in the second and third interviews than in the first.

The interviews lasted around 45 minutes and had aspects of focus group interviews where topics were discussed freely and the interviewers acted as moderators. The focus group approach was chosen in order to display as many viewpoints as possible and to capture potential tensions between viewpoints. In addition to being a source of research data, the group interviews served as an

arena for the participants to develop the project further through an exchange of views and ideas. This purpose was communicated to the participants and probably contributed to a high engagement in discussing the topics.

The categories of conditions that describe the conditions that had led to teacher involvement in the project were developed in several steps. The initial step was inductive and was based on the researchers' reflections on their own experiences of collaborating in the project and discussions of what had possibly led to the experienced, deep involvement of the teachers. This process resulted in a set of initial categories. In the second step, the interview data were coded deductively in terms of these categories by the first author of this paper. We then adjusted the categories in light of what the teachers actually expressed, which means that this step also got an inductive turn. The interview material was then coded by the second author. The results showed quite different coding. When comparing, it became evident that this was a result of the conditions represented in the categories being deeply interrelated and that statements from teachers often touched upon several conditions. Through discussion of what the categories mean, we refined descriptions and adjusted the naming of categories, and agreement was achieved. For example, two initial categories named *autonomy within the task* and *joint responsibility beyond own practice* were changed to one category named *autonomy and responsibility,* since we found that autonomy and responsibility were highly related in what the teachers said.

Finally, the full manuscript was sent to all the participants for feedback as a way of conducting a "member check" (Thomas, 2017). A member check is often seen as a way of validating findings from qualitative studies and enhancing credibility. Nonetheless, few studies report how feedback from respondents leads to changes in research outcomes, and it has been argued that the idea of a member check as a validation method assumes that there exists a "correct" interpretation of qualitative data (see Goldblatt, Karnieli-Miller, & Neumann, 2011; Thomas, 2017). However, in studies like the one presented in this paper, where participants are fully capable of comprehending the analytical results, participants should be asked for feedback to prevent the study from missing out on important aspects of the phenomenon under investigation. This can actually be seen as a way of bridging the research-practice gap by means of 'boundary encounters', as described by Goos (2014), since it gives the teachers a sense of how the community of educational researchers works and how their own discussions and reflections may result in a research product.

The participant feedback procedure followed the synthesised member checking method outlined by Birt, Scott, Cavers, Campbell, and Walter (2016). The method addresses the co-constructed nature of knowledge by providing participants with the opportunity to engage with, and add to, raw data as well as interpreted data. The teachers' responses and how these influenced the description of the identified conditions are presented at the end of the results section.

Results: Conditions for the active involvement of teachers in the project

The analytic process has resulted in four interrelated conditions for the active involvement of teachers in the KreTek project. These are:

1. A shared and relevant challenge
2. An open entrance to the project
3. An allocated time and meeting space
4. Responsibility and autonomy

Each condition will be elaborated on in depth in the following, with presentation of evidence from the interview data.

Condition 1. A shared and relevant challenge

The KreTek project set out to generate results that could meet the challenges teachers face with the new curriculum. It is ambitious in attempting to combine pupils' deep learning in science and mathematics with technology (programming) and creativity. Contrary to many other projects initiated by researchers, there were no clear models for how this could be achieved at the outset of the project. This means that the challenge was truly *shared*. Since programming forms part of the curriculum that all schools are to implement, the pilot teachers experience the challenge as highly relevant to their work. The relevance is individual in the sense that all teachers must realise the new curriculum; one pilot teacher commented that the motivation might not have been so high if this was not the case.

However, it is also important that the challenge, at least the part involving programming, is shared with *all* teachers. In discussing the challenges that the new curriculum brings, pilot teacher T7 asks with reference to the national education authorities what they are actually expecting from teachers:

> T7: What do they really expect from all the teachers?
> T8: Well, the school's principal is the one who is responsible, but the reform is to be implemented now. We have not made that decision ourselves, it is the government who has decided that this is to be done, so we must just try to do our best.

The response from the other teacher T8 places the formal responsibility for the new curriculum requirements with the authorities politically and institutionally. However, the operational responsibility is left with the teachers who just have to try their best. This challenge, represented by new directions that must be implemented in all schools, appears to give direction to teachers' work in the project and motivates them because the result, if successful, will be useful to all teachers. Pilot teacher T2 expresses this motivation when responding to a suggestion from another pilot teacher about designing teaching material with a gradual progression, not only for students but also for teachers:

> T2: There's something we should think about, to make the progression gradually … I think there are a lot of teachers around the country now who think: programming is to be included, but we do not want

> to do too much programming because we have not mastered it well enough ourselves yet. And then it is like you say, that throwing themselves into the unknown and embarking on one of our projects, that is what we hope will happen. But I think we must try to lower the threshold for them.

This quote illustrates that the pilot teachers meet the shared challenge by taking responsibility for supporting other teachers; this attitude will be further elaborated in the description of Condition 4.

Condition 2. An open entrance to the project

The shared challenge described above facilitates an open entrance to the project. By 'open entrance' we mean that there are no predefined solutions or models that the researchers bring into the project. When discussing what is needed for teachers' development, one of the pilot teachers expressed that s/he appreciated the open start and the free experimentation with electricity equipment that took place in one of the first meetings in KreTek:

> T4: I really liked that we had a rather open start, and then we used the technology set, and everyone found something that they liked themselves. (...) It was not like "Here comes something external enforced on me". But that I benefit from it in my own way, that is motivating.

The lack of *"*something external enforced on me*"* that the teacher mentions corresponds with what Engeström (2011) describes as a characteristic of formative interventions in contrast to design experiments: they involve problems that are embedded in participants' activity, and the solution is not known to the researchers.

In KreTek, the open entrance to the project meant that not only the problem but also the method of approaching it was open for direction from the pilot teachers. In the beginning, this caused some confusion about what was expected. Pilot teacher T1 describes this as an opportunity:

> T1: What I think now is that in the beginning of the project, the first time we met, you and the project leader were clear that this is not something we have ready-made ... we will figure it out together. We have support from the university, and we have each other and everything we need. ... I think such a start contributed to... we get a little more like that: OK, this is something we figure out together. Then it is easier to throw out ideas.

The pilot teacher here describes how the open situation made it easier to bring in new ideas and to shape the project in collaboration.

Condition 3. An allocated time and meeting space

The time allocated for the teachers is an obvious prerequisite for the success of the project. However, time in itself is not sufficient, and the key is rather that the participating schools have made time available (with no timetabled teaching) at the *same* time of the week for all eight pilot teachers. During the development of the project, the teachers expressed a wish for meeting in the group more often than planned by the project leader. One teacher characterizes these meetings as a "break" in the middle of the week:

> T6: To me, it feels like a break in the working week. Because during other workdays the pace is so high that I feel that I have to work as fast as I can. Then I come here, and we are allowed to spend time, we are allowed to discuss things we like, things that are fun to talk about.

We interpret the "break" not as being free from work, but as work at a different pace and in a different setting. In daily work at a school, the pace is quick, and teachers will soon be involved in all those unpredictable events that take place. Pilot teacher T1 compares this to the alternative of working with the project at the school or at home on the half day allocated each Wednesday:

> T1: There are three alternatives on a Wednesday if you think openly. The first alternative is to meet here with the other pilot teachers. Number two is to sit at your desk at school to work, and number three is to work from home. I think it is most effective to come here. Not only because... one thing is to meet each other and the opportunity to have discussions with the others. But it also has something to do with the fact that we are very focused when we meet here. This is KreTek. If you sit at a school and work on a project, you get five minutes between each time someone comes in the door and wants to talk about a pupil or inform you about things or just ask about what you are doing. At school, you get so little time without interruptions. When we meet here, we have KreTek time and can focus on the project.

One teacher expressed in the participant feedback that the long-term nature of the collaboration is also important, which is in line with how Brodie (2019) identified time for long-term inquiry as one of the key features of a professional learning community. The teacher explains that the long project period contributed to the development of the teachers' knowledge, increased involvement and led to relatedness in the group. In turn, this created a sense of safety such that the teachers' subject-specific knowledge could develop.

Even if the pilot teachers valued the open entrance to the project and the opportunity to focus, they stressed that the time allocated also needs some structure. Teacher T6 formulates time and structure as the two important conditions for a successful curriculum reform that leads to changes in schools:

> T6: I think there are two things: It's time, but also the way we work. It's not just about allocating time, because I have worked in departments where we got the time, but we did not know what we were expected to spend that time on, and that is completely useless. There must be some goal set for the work. In other words, some structures in order to achieve something.

The pilot teachers expressed that they value working together to meet this challenge, and compares meeting colleagues in the KreTek setting to the daily life in school:

> T1: ...you get stuck, and when one works like we do now, we encounter the challenges together. Then time, space, and resources are spent to solve the problems as we go, quite effectively. Effectively enough so we do not get tired and give up. You always have someone to exchange thoughts with who works with similar stuff. Instead of sitting in a teacher's room with a teacher of Norwegian language, a social science teacher and an English teacher who don't know anything about this ... I think we get enough space, that we get to meet, that we get the opportunity to talk together.

It is noteworthy that this teacher sees it as more *effective* to meet with the other pilot teachers in order to solve problems and keep up the motivation and pace. However, the collaboration also has a social dimension; in the participant feedback, one teacher commented that social aspects such as eating together and some social events have been important. These factors seem to have contributed to community building and relatedness in the group.

Condition 4. Responsibility and autonomy

The pilot teachers expressed a clear vision of contributing to the improvement of teaching among other teachers and other schools. This is embedded in the term "pilot teachers" used by the project, and the message is received in how teacher T8 describes how s/he experience being a pilot teacher in the project:

> T4: We are approaching the piloting now; we are going to be in front and test something for the first time. That's one part of the role we have not tried out yet. (...) Because that's how I understand the word "pilot teacher", that we are to try out something new.

This aspect of the project seems to motivate the pilot teachers, and it gives them a sense of trust and responsibility. The responsibility they take on goes beyond their own practice as teachers. This is evident in how, for example, teacher T2 describes that what they develop must have a low threshold for other teachers to use, as referred under Condition 1.

It seems to benefit the process that the pilot teachers come from different schools and meet in this particular group. To a question about why the group of pilot teachers seems to work so well, teacher T2 responds that the mix of participating teachers is constructive. The following discussion presents more aspects of the issue:

> T2: The mix of teachers.
> T1: Yes, I think that is important. Because I believe that, at least as I see it, there is ... a total of eight people who are curious and want to achieve something. And that makes it easier, in a way.
> T3: Yes, that's what I'm thinking too. It's fun to work because the attitude is a bit like: How can we solve this? It's not like: "No, it's not enough time".
> (...)
> T1: Yes, that's my experience at the school where I work now ... it may be me or others who come up with an idea ... and the idea is met with something like: "Well, I don't think there will be time for that". It's typical, and ... it's so nice when you come a place where people say: "Yes, let's do it!", "This is something we will manage!" And then the collaboration works well, yes.

This exchange shows that the pilot teachers agree that the project meetings are motivating because they engage with colleagues who have a commitment. They phrase this in contrast to reactions they meet at their own school, where colleagues may respond to ideas with the argument that there is not enough time. Teacher T1's description of his/her experience as "typical" in the quote above indicates that this is seen as a typical aspect of school culture.

Within certain frames, the pilot teachers have been involved in defining not only the content but also the progress of the project. On a question of what the pilot teachers feel is expected from them, teacher T5 describes how they actually have been able to define the expectations themselves:

> T5: We have been involved in defining the expectations, we have been involved in deciding deadlines and how we want to organize the work. And then it becomes quite easy to relate to it, because we do not feel it's enforced on us like, "The deadline for delivering this will be Wednesday", because we have been involved in the decisions. I think that we strongly agree on the expectations that are set as a group. It's not just the KreTek project manager that decides... And I think that works well, it works for me.

The quote signals an autonomy that is collective in defining expectations and making decisions. For T5, this seems to contribute to motivation and ownership, which, in turn, keeps up the commitment over time.

The pilot teachers expressed a clear understanding that the responsibility for development lies with themselves. They were asked if they felt that the university staff should have contributed more to the development. The two following responses illustrate that the teachers see the university participants as having a role in supporting the development rather than defining it:

> T5: Even though we have not involved the university people, I think we have managed to share the knowledge that we already have in our group. I think I have received a lot of help, even without the university staff.
> ---
> T7: In what I have been doing, I have not needed much support from the university. But some of the teachers working with sensors and stuff ... when they have asked for help on that, then they have got support.

The support role they place the researchers and other university participants in is evident from the formulations "help",

"support" and in particular T5's expression about "involving university people", where s/he clearly sees the pilot teachers as in charge of the development in the process.

The pilot teachers appreciate the trust and autonomy they are given in the project. Pilot teacher T8 puts this in contrast to what could have been the case if solutions were developed by experts from the university:

> T8: I think it would have been difficult if someone from the university had come to us and said: "You are going to do this. Somebody has to try this out". (…) People working at the university who don't know schools very well may not have a very good grasp of what an 8th grader can achieve.

This shows that the teacher sees it as important to embed not only the problem but also solutions in teachers' practices in a project that aspires to develop practice in schools.

Participant feedback

Five of the eight pilot teachers gave responses after having read the manuscript. Two of them mainly confirmed that they found that the identified conditions were representative of their experience, while three also gave more substantial input. They commented on specific aspects already described that they found particularly important: the assigned time on the same day of the week, the opportunities to influence the development of the project and that university participants function as support rather than as defining agents in the project's development. However, the feedback raised two new aspects that led to an adjustment of the description of Condition 3 (an allocated time and meeting space), namely, the *long-term* nature of the collaboration and its *social aspects.*

One response could have given rise to a new category, as the teacher commented that the project meets his or her *own* needs in teaching and hence creates a personal benefit. S/he saw this as an important motivation to make an effort. Since this aspect had not been mentioned by other teachers, rather than establishing a new category, it was included in Condition 1 (a shared and relevant challenge), which was given an extended meaning and description as result of the participant's feedback.

Discussion

This study has investigated conditions for the active involvement of teachers in a DBR project in the case of the KreTek project. So far, we have not made claims about the quality of the *outcomes* of the project, and this is an important limitation of the study. The contribution of the study is rather to identify conditions for how the potential of DBR—in being deeply situated in an educational context and involving constructive collaborative partnerships as described by, e.g., Anderson and Shattuck (2012)—can be realised in concrete terms. The deep involvement of teachers is important for the development of resources that other teachers find usable and relevant, that is, '*practicality'* as described by Nieveen (1999) and Plomp (2007) as one of the criteria for high-quality interventions.

The most self-evident condition for teacher involvement is the available time for the pilot teachers to work on the project (Condition 3). Working time requires money, and this means that teachers' working time should be calculated in research costs involving DBR. The time resources provided are an aspect of the criterion of 'practicality', as the teachers' insights into the opportunities and limitations of the school context will be embedded in the development from the very start. This ensures that the designed outcome is usable in the context it is meant for. However, available time is clearly not enough, as results indicate that the allocated meeting space, the shared challenge and the teachers' experienced responsibility and autonomy are all essential conditions for making constructive use of the time resource provided. Furthermore, the DBR literature emphasizes that a DBR process should be situated in a real educational context by addressing real-world problems (Anderson & Shattuck, 2012; Reeves & McKenney, 2012). Condition 1, a shared and relevant challenge identified in the present study, stipulates that the real-world problem should be not only a local or individual challenge but experienced by and shared with the whole community of teachers. This provides for the sense of responsibility captured by Condition 4, responsibility and autonomy. Autonomy seems to be essential in encouraging the engagement that this experienced responsibility creates for the teachers. Condition 2, an open entrance to the project, is also in line with the principles described in the DBR literature (e.g. Anderson & Shattuck, 2012; Reeves & McKenney, 2012) in terms of the aim of contributing to solving real-world problems, since this requires an openness to what these problems are. However, our results from the KreTek project have shown that an openness that allows for and encourages teachers' initiative is essential for their deep involvement. Other studies have reported that teachers play a peripheral role in DBR projects that is limited to implementation and refinement of the researchers' ideas, and the teachers hence become tools for researchers in realising their own ideas in schools (Andrée et al., 2020; Engeström, 2011; Hamza, Piqueras, Wickman, & Angelin, 2018; Sensevy et al., 2013; Sterner, 2019). On the contrary, the pilot teachers in the KreTek project seem to consider the researchers involved in the project as *their* toolbox for development; that is, the roles of teachers and researchers have been altered from what is often the case. The condition for this to happen was probably that the researchers did not have a pre-defined plan for the design and that this openness was communicated to the participating teachers at an early stage. The problem to solve was hence an authentic problem for all participants in the project. This is in line with the pragmatic approach to DBR described by Juuti et al. (2016), where the researchers do not know how to act.

Teachers' lack of active participation has been ascribed in research literature to a lack of pedagogical content knowledge, differences in beliefs and values and fundamental differences in the communities practice teachers and researchers represent (see Andrée et al., 2020; Bogaerds-Hazenberg et al., 2019; Goos, 2014). Are researchers underestimating teachers' ability to participate actively and

constructively in development projects? Experiences from the KreTek project indicate that teachers are fully capable of going deep into a development project. We believe that the key to understanding why this is often not the result lies in the pace and complexity of teachers' daily work, which leaves little room for in-depth discussion and reflection over time. This is nicely described by pilot teacher T1: *"If you sit at a school and work on the project, you get five minutes between each time someone comes in the door…"*. Along similar lines, T6 described the weekly project meetings as a "break in the working week", not because they are not working but because the work is different in nature. Resources in terms of working time for the teachers and a meeting space outside their school have provided opportunities for them to be 'thinkers' and not only 'doers', as discussed by Sensevy et al. (2013) and Andrée et al. (2020). Boundary encounters' as described by Goos (2014), where teachers and researchers are given a sense of the logic of the other group's community, may certainly have some value. However, letting teachers work within frames that allow for deep involvement may have more significant effects. Such frames may more effectively provide for educational innovations that are deeply grounded in practitioners' contexts and real needs in schools.

The motivation to make an effort has clearly been a factor, as it is high among the eight teachers in the KreTek project. Motivation and engagement could have been defined among the conditions we have identified to explain the active involvement of teachers in the project. However, we believe that many teachers have the potential to show the required motivation, and that there are other conditions at work that redeem this potential into action and involvement.

In self-determination theory, Deci and Ryan (2000) have presented three psychological needs that foster self-determination: *competence, autonomy* and *relatedness*. These three needs seem to have been fulfilled for the pilot teachers in the KreTek project, and this may contribute to their active and lasting engagement. The frequent meetings and time allocated appear to have been essential in this respect. This is because the participants' experienced *competence* is dependent on an exchange of knowledge and skills within the group and on the availability of university staff for assistance when needed. *Autonomy* is explicitly inherent in one of the identified conditions, and *relatedness* is facilitated by the meeting space provided by the project and by the mutual responsibility and commitment that the group developed.

The results indicate that the group of pilot teachers, within the frame of the KreTek project, has developed a specific *professional learning community* with the key features described by Brodie (2019): a clear and shared focus that provides for interesting and challenging discussions; a shared agency; support from school leadership; time for long-term inquiry; and mutual trust in the group of collaborators. The way the teachers reflect on their participation in KreTek relates to professional communities on two levels, internally and externally to the project group. On the *internal* level, the condition of an open entrance to the project has been important in order for the professional learning community to develop in the group and resonates with how Juuti et al. (2016) have described a pragmatic perspective on DBR. This implies that the starting point of a DBR project is a situation where teachers and researchers do not know how to act and where the researchers do not have a pre-defined solution. However, the results of the present study indicate that a clearly defined and shared *challenge* is important in giving direction to the work. It is here important that the challenge is one with relevance to the profession as a whole and not restricted to local settings or individual needs. This represents the *external* level of the professional community, which involves a responsibility beyond the teachers' own practice and school context. It mirrors how Rose et al. (2015) have described *professional competence* as including abilities to influence others and contribute to the advancement of the profession. In project design, this requires trust in teachers' abilities to fill this role and acceptance that development of the profession is best done by representatives of that profession. The success of the KreTek project in involving teachers deeply in the project resonates with the description of teacher professionalism as described by Klette (2000) and others. Teacher professionalism is represented in the way the pilot teachers in KreTek develop a shared knowledge and have control over the development, and the way they feel responsibility that can be seen as representing a professional commitment.

It may be argued that the way the KreTek project is run will not work for *all* teachers. That is true, since the pilot teachers in the project were purposely selected. Generalization to the entire population of teachers is, however, not the purpose of this study. All professional communities have representatives that are leading development, and the way the pilot teachers in the KreTek project speak of themselves as—precisely—*pilot* teachers, as those who are in front, shows that they take this role very seriously. Again, this links to teacher professionalism in terms of collegial rather than bureaucratic control over practice, at least internally in the project.

Conclusion

Based on the experiences and interview data of the eight pilot teachers in KreTek, this paper has identified four interrelated conditions that have led to the active involvement of the teachers in the project. We have shown how these conditions link to the more general principles of DBR and how they are realised in concrete terms and described by teachers in the case of a particular project.

We have argued that the success in engaging teachers deeply in a DBR project links to teacher professionalism, and that the teachers have developed what can be seen as a professional learning community. A key to this development seems to be the combination of the teachers' responsibility, autonomy and opportunities provided in terms of time and other resources, and that they experience a responsibility beyond their own teaching and local context. Teacher collaboration and professional development are often seen as too limited regarding the development of the practice of individual teachers and schools (Kelchtermans, 2006; Little, 1990). Contrary to this, DBR

projects may contribute to professionalizing teachers on a collective level when they fulfil the conditions for active involvement of teachers identified in this paper with allocated time and resources and with emphasis on trust, responsibility, and autonomy.

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Competing Interests

The authors have no competing interests to declare.

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