Chapter 1

GENERAL INTRODUCTION

1.1 Introduction

"Change in education is easy to propose, hard to implement, and extraordinary difficult to sustain" (Hargreaves & Fink, 2006, p.6)

A large number of educational reforms have been proposed in recent decades. However, the implementation of most of these proposals in teachers' classroom practices have been found to be problematic (Fullan, 2007). Many attempts failed or were not implemented according to the original design, with the risk of losing the essence of the reform proposal. How is it then, that most change proposals are poorly adopted by schools and teachers? To understand this, we need to focus on the teacher, the work of teaching and the challenges that this brings. In the process of implementing educational reforms, teachers are the "key agents" for achieving changed classroom practices (Borko, Elliott, & Uchiyama, 2002; Fullan, 2007; Spillane, 1999). To successfully implement a reform proposal, teachers need to enact the proposed reform in their daily teaching practices. A problem with this is that change proposals are mostly formulated as visions or ideals and seldom as programs for practice (Borko, 2004). Teachers have to translate such visions into practices, which they rarely do according to the original design of the reform (Remillard, 2005; Van den Akker, 2003). In the process of translating a vision or ideal into practice, teachers tend to domesticate the proposed reform into familiar practices (Doyle & Rosemartin, 2012). The reason for such failure to implement change can best be understood by examining the work of teaching and the challenges that it brings. A teacher has to teach relatively large groups of students with a variety of backgrounds, having limited time, space, and resources. In addition, a teacher has multiple goals that he/she wants to achieve that are always present to guide decisions such as promoting student willingness to participate, covering content or fostering learning (Kennedy, 2005). In short, teachers work in a complex and demanding classroom ecology (Doyle, 2006) that holds certain limitations and challenges. To cope with this, teachers have

developed routines over time that have become part of the fabric of everyday classroom life (Janssen, Westbroek, Doyle, & Van Driel, 2013). When teachers are confronted with a reform proposal, the language of the reform proposal simply seems to be incongruent with their everyday, routinized practices.

The question then becomes how to bridge the gap between the world of educational reforms and the practical demands of everyday classroom teaching. Already in 1977, Doyle and Ponder posed that teachers will only implement change in their classrooms if they consider it to be practical. His practicality theory prescribes that for successful implementation of change, the change proposal needs to contain instrumental content, be congruent with regular teaching practices and cost little time and effort. To date however, the majority of educational reforms seem to have overlooked these important criteria of practicality theory.

In settings where educational change is required, teachers are asked to (1) learn new knowledge or skills, (2) understand the meaning of the change proposal and (3) be willing to change (Fishbein & Ajzen, 2010; Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2010). Such teacher learning is mostly facilitated by offering teachers professional development (PD) opportunities. Literature shows several features of high-quality PD such as situating teacher support in practice and addressing problems of practice, focusing on student learning, giving teachers opportunities to learn actively, taking teachers´ regular practices as starting point for change and making the support school-based (Borko, Jacobs, & Koellner, 2010; Garet, Porter, Desimone, Birman, & Yoon, 2001; Supovitz & Turner, 2001; Van Veen, Zwart, Meirink, & Verloop, 2010). Although such features of effective PD can be very helpful in designing a PD program that supports the implementation of an educational reform, we propose that a crucial element is missing: practicality.

This research project was aimed to make a context-based educational reform practical for implementation in Dutch biology education. The context-based reform proposal predominantly comprises the introduction of a context-based curriculum, where biological topics are organized and taught by using contexts that help learners to connect new knowledge to prior knowledge and come to see the important role of biology in society and professions (Boersma et al., 2007). The context-based reform proposal was implemented in September 2013.

In the present research, two approaches were used to make the reform proposal practical: a modular approach and a success-oriented approach; these are further elaborated in section 1.3.3. The focus of this research was to make a context-based reform practical and explore the resulting development of teachers' instructional approaches and their intentions to implement the reform.

1.2 Context of the study

This study was conducted in the setting of a national reform for biology education. In a joint report (KNAW, 2003), several stakeholders identified three problems in biology education: a lack of relevance, a lack of coherence (especially between biological concepts), and an overloaded curriculum. In response to this, the minister of education, culture, and science established a National Biology Education Innovation Committee (CVBO) which was charged with the task of working out a solution to the three identified problems. In 2007, the CVBO committee proposed a context-based curriculum for Dutch biology education (Boersma et al., 2007). This proposal predominantly comprised an update of the biological subject matter and a revision of the biological concepts and skills to be learned for the final examinations. However, the committee did acknowledge the inevitable effects on teaching practices and also formulated guidelines for designing context-based lessons. Our research was aimed at assisting teachers in bridging the gap between the proposed curriculum change and their regular, day-to-day practices by making the context-based change proposal practical.

This research was part of a broader research program in the Netherlands (DUDOC). In the DUDOC program (2007-2012), 20 science and mathematics teachers (pre-university education) were trained to become educational researchers while carrying out a PhD project for three days a week and meanwhile continuing to teach in secondary schools for approximately two days a week. The focus of the DUDOC research program was to support the implementation of the current reforms in science and maths and make the implementation more evidence-based.

1.3 Conceptual framework

In this section, we describe three important elements of our research: Context-based education (1.3.1), professional development programs in the context of educational reform (1.3.2), and the concept of practicality (1.3.3).

1.3.1 Context-based education

Context-based education is an approach to education in which subject matter is organized and taught by using contexts. It is not only advocated in the Netherlands, but has already been implemented in several other countries; for example, Salter's science in Great Britain (Bennett & Lubben, 2006) and "Chemie in kontext" in Germany (Parchmann, Gräsel, Baer, Nentwig, Demuth, & Ralle, 2006). The use of a context to teach subject matter is thought to bridge the gap between the often abstract and difficult scientific concepts and the world the students live in (Kortland, 2007). Students often see school science as disconnected from the real world, leaving them with little interest in science, little understanding of the role of science in society and little awareness of career possibilities in the field of science (Solomon, 1996; Boersma et al., 2007; Bennett, Lubben, & Hogarth, 2007). In more traditional approaches to school science, both in teaching approaches and textbooks, science was a mere accumulation of facts in which students had to memorize the main scientific ideas with little application of those ideas in real-world problems (Solomon, 1996; Bennett et al., 2007; Gage, 2009).

Reviews of the effects of context-based education show that it can: a. Make students feel more positive towards science and increase the perceived relevance of scientific topics (Bennett et al., 2007); b. Help students come to see the important role of science in society (Bulte, Westbroek, de Jong, & Pilot, 2006); c. Evoke students' misconceptions (Scott, Asoko, & Leach, 2007); d. Help students to learn how to self-regulate their learning processes (Bennett et al., 2007) and e. Help to move the emphasis away from learning scientific 'facts' to involving students in scientific activities for which they develop skills (Krajcik, McNeill, & Reiser, 2008).

At the classroom level, the teaching-learning process of context-based education typically focuses on a meaningful context that is presented at the start of a lesson (Bennett et al., 2007). From this context, a problem or question naturally

follows that develops a 'need-to-know' for scientific concepts (Bulte, Westbroek, de Jong, & Pilot, 2006; Wieringa, Janssen, & Van Driel, 2010). Following, students have to gain insight in the concepts that are needed to answer the question or solve the problem (Bennet et al., 2007; Glynn & Kobala, 2005). There can be two options for this: students' self-regulation or a teachers' regulation (Vermunt, 1998; Zimmerman, 2002). In the first option, students have to perform certain activities themselves to answer the question or solve the problem by, e.g., searching for necessary information or relating important concepts. This is followed by reflection on the content and process of learning. In the second option, the teacher regulates learning by, e.g., presenting the needed information. This is then followed by providing students with learning activities in which they have to answer the question or solve the problem.

In order to define the term 'context', authors have proposed many descriptions such as personal situations, cases, future professions, themes, or practices (Aikenhead, 2007; Goedhart, 2004; Pilot & Bulte, 2006). In the Dutch setting, the CVBO chose to base their definition of a context on Vygotsky's sociocultural perspective and the closely related activity theory (Boersma et al., 2007; Vygotsky, 1978). A context is hence seen as a *social practice* in which practitioners participate in a central, historical activity (Van Oers, 1998). What follows from this view is that learning activities at classroom level can only have meaning when they are situated in authentic, real-world, historical, social, and culturally defined practices (Boersma et al., 2007). Other authors argue that this is only one option for using contexts. Mapping the terrain, Gilbert (2006) proposed four much-used models of contexts: (1) a direct application of concepts, (2) a reciprocal relationship between concepts and applications, (3) a personal mental activity (e.g., a personal narrative of a major event that relates to the concept), (4) a context as a social practice where learners see themselves as participants in a historical community of practice.

In our research project, we offered the participating biology teachers a short overview of these four models of contexts. From this, they were able to choose the type of context they wanted to use; this could differ between participants and change over time. Contexts should, however, be relevant to students with diverse backgrounds (Glynn & Kobala, 2005). The main reason for not giving a narrow definition of a context is that the participants in our research were being supported in making stepwise changes in the

direction of context-based education, with their regular practices as the starting point for development. And as these regular practices could be rather traditional, offering a fixed definition, such as proposed by the Dutch reform committee (CVBO), could turn out problematical for starting teachers' development. Finally, as the participants in our research designed one lesson at the time, they could hardly design lessons in which the concepts learned in one context were used or applied in another context. The notion of recontextualization (Van Oers, 2001) was, therefore, not part of this research.

1.3.2 Professional development in the context of educational reform

The changes in classroom practices demanded by reform visions ultimately rely on teachers (Borko, 2004, p.3)

Changes to teachers' classroom practices are hard to make on the basis of the visions and rationales that are presented in reform proposals. If they were easy, more classrooms would look like the ones envisioned by reformers (Wilson, Peterson, Ball, & Cohen, 1996). Changes in classroom practices require a great deal of learning on the part of teachers, which is difficult without support and guidance in the form of professional development (PD) initiatives (Ball & Cohen, 1999; Borko & Putnam, 1996). As Borko et al. (2002) put it: without PD, educational reforms are doomed to fail. Many authors have presented lists and overviews of characteristics or features of designing effective PD opportunities (Desimone, 2009; Garet et al., 2001; Guskey, 2000; Loucks-Horsley et al., 2010; Supovitz & Turner, 2001; Van Veen, Zwart, Meirink, & Verloop, 2010). In this section, we will predominantly use the recent and extensive review by Borko et al. (2010) as a basis for discussing such principles. They present the following features for effective PD: (1) PD content is situated in practice and addresses problems of practice, which helps teachers to see the relevance of the PD. Concrete tasks such as designing, teaching and reflecting on concrete lessons and classes helps them to make connections between the new PD content and their existing classroom practice (Darling-Hammond & McLaughlin, 1995). PD programs presented in isolation from teachers' actual classroom practices are doomed to fail (Lieberman & Pointer Mace, 2008). (2) The content of PD is focused on students' learning, because that is considered to be the ultimate goal of education (Fishman, Marx, Best, & Tal, 2003). (3) The preferred

instructional practices are modelled in the PD. (4) Teachers learn actively, because acquired knowledge doesn't transfer immediately into more effective practice; teachers have to practice and experience the effects of changes themselves (Guskey, 2000). (5) Teachers preferably learn collaboratively and in professional learning communities. (6) The PD setting is school-based, and (7) PD opportunities or models are preferably ongoing and sustainable.

1.3.3 Practicality

Professional development (PD) initiatives are highly needed in the implementation of educational reforms because teachers are typically asked to teach in ways that are significantly different from their regular practices (Borko, Elliot & Uchiyama, 2002). The above-mentioned set of criteria for effective PD serves as a good, evidence-based set of guidelines for designing PD programs that are aimed at achieving changes in classroom practices. However, upon closer inspection there seem to be two problems with these features: they hardly seem to be useful in concrete settings for shaping PD, and the classroom settings seem to be neglected. The first problem appears when using the guidelines to design, e.g., a PD program. Borko et al. (2010) states that effective PD programs address problems of practice and include concrete tasks such as lesson design, actual enactment of such lessons and reflection. However, this does not specify in what way these problems should be addressed or how lesson design or reflection can lead to fundamental changes in teaching practices. Nor does it specify how teachers' existing practices are taken into account when designing lessons. Another feature of effective PD states that teachers should be focused on student learning. It does not specify, however, how teachers should come to know their students´ learning outcomes or how they can use such knowledge to make changes that positively affect those outcomes. The second problem with these principles is that they seem to overlook the settings in which teaching takes place. Doyle (2006) has argued that classroom life is a multifaceted setting where many things happen simultaneously and where many actors all have their goals and interests. In the midst of that, teachers must orchestrate and sustain a safe and challenging environment where they try to accomplish multiple goals such as keeping momentum, covering scheduled content, or attending to students' emotional needs (Kennedy, 2005). In such a demanding classroom ecology (Doyle,

2006), teachers are known to have formed routinized, functional approaches to teaching which help them to cope with not only their own demands, but also the demands of school management, national standards, and parents. In these challenging settings, teachers have little time and possibility to think about change, especially when they do not see the immediate benefits for their classrooms. Teachers will, therefore, only implement a change proposal when they consider it to be practical for their classrooms (Doyle & Ponder, 1977). Practicality is defined as "an expression of teacher perceptions of the potential consequences of attempting to implement a change proposal in the classroom." (Doyle & Ponder, 1977, p.6). A change proposal is considered to be practical when it meets the following three criteria: a. Teachers should be able to envision how that change proposal would work out in their classrooms (*instrumental*); b. The content of the proposal should be connected to how teachers regularly teach (*congruent*); and c. The proposal should have high benefits and low costs in terms of effort and time (*cost*). In this way, practicality theory seems to hold a solution to the two problems described earlier: It describes three criteria for making abstract change proposals more practical and it pays attention to the classroom ecology. However, these criteria are still rather descriptive; they need further elaboration and specification for concrete settings. In the present research, these criteria were further elaborated into two approaches.

First, a modular approach was proposed that is focused on the use of lesson segments that teachers already know and regularly use (e.g., *tell, apply, test*). This approach is primarily based on work by Holland (2000). He showed in his research that any innovation can best be seen as the rearrangement and adaptation of already existing segments. Janssen et al. (2013a) have translated this idea to the field of education and proposed the use of smaller segments to innovate. The modular approach used in this research uses lesson segments to design and redesign many forms of instructional strategies through the recombination and adaptation of already existing lesson segments. In this research, the lesson segments were used to (1) represent teachers' regular instructional approach (2) represent the instructional approach of the context-based reform proposal, and (3) assist teachers in making steps using their regular instructional approach as starting point. Because the lesson segments were formulated at classroom level and provided instrumental content for the reform proposal, the hypothesis was that this would specifically increase the instrumentality of context-based education.

Second, a success-oriented approach was proposed. This approach is briefly introduced in this section; for further elaboration, see Chapter 3. It is known that building on what teachers already do and relating proposed changes to regular teaching practices can be very effective in achieving change (Darling-Hammond & McLaughlin, 1995; Putnam & Borko, 1997). This can, however, be done in several ways. In this research, we pose that teachers should not so much build on what they already do by working on their deficiencies, but rather build on their earlier successful experiences. Building on successful experiences is predominantly based on elements of positive psychology (Seligman, 2002) and the solution-focused approach from the field of psychotherapy (De Shazer, 1985; Miller, Hubble, & Duncan, 1996). This latter approach is a widely used method to motivate people to make changes that are based on their personal strengths and earlier successful experiences. Solution-focused psychotherapy starts not by focusing on problems, but by exploring the target situation. It then proceeds to check if there has ever been a situation in which the problem was not present or (part of) a solution was already successfully present. Such earlier successful experiences are then further discussed in order to propose solutions for the current problem and directions for change. The assumption is that there have always been situations in which parts of the solution were already present. Translating this approach to the world of education, Janssen, De Hullu, & Tigelaar (2008) showed that pre-service teachers formulated stronger intentions to change when reflecting on successful experiences than on problematic ones. Specifically for educational reforms, this would mean that thinking back to earlier successful experiences could assist teachers in the formulation of strong intentions to change in the direction of the reform. In the present research, we proposed that there could be two sources for finding earlier successful experiences: the teachers' own experiences and external students' data such as students' learning outcomes. The hypothesis was that building upon earlier successful experiences could promote the congruency of the context-based reform.

Finally, the combination of the modular and the success-oriented approaches uses that which is already present and facilitates teachers in making stepwise changes to their practices, which is expected to have low costs and high benefits at the classroom level. And as this research was school-based and situated in teachers' actual classroom practices, the hypothesis was that such an approach would also reduce the amount of time and effort needed and, therefore, result in low costs.

1.4 Research goal

The research goal for this study was to make a context-based educational reform practical and explore the resulting development of teachers' instructional approaches and intentions to implement the reform. The context-based reform was made practical using two approaches: a modular and a success-oriented approach. The outcomes were used to determine implications for the implementation strategy of the context-based reform in Dutch biology education. The overarching research question was:

How can the context-based approach to biology education be made practical for teachers?

This overall research question was answered by conducting four studies; these are described in the next section. In Chapters 4 and 5, we describe how both the modular and success-oriented approach were used to design a PD program aimed at learning teachers how to design context-based education (Chapter 4) and how to use students' data to implement change (Chapter 5). In Chapter 3, the same two approaches were used as a basis for a motivational interview technique aimed at eliciting teachers' strong intentions to change in line with the reform. Prior to these studies, however, we conducted a study to construct and internally validate an ID model containing a set of lesson segments that could be used in the modular approach (Chapter 2).

1.5 Overview of the study

Chapter Two

Chapter two describes the model construction and validation study that formed the start of this research project. The requirements for this model were that it had to be both practical and usable, not only by biology teachers, but by teachers in all subjects and in many different settings. On the basis of literature on ID models (Merrill, 2001; Gustafson & Branch, 2002), we aimed to construct and internally validate an Instructional Design (ID) model consisting modular lesson segments. The main goal for this ID model was to assist teachers in the expansion of their existing teaching repertoire and to enable teachers to use the lesson segments to design a large variety of lessons.

Using the lesson segments, teachers should be able to increase their teaching repertoire, which would then help them to design an instructional approach for specific settings or learners. The lesson segments should also be usable in making stepwise changes from more traditional instruction towards the instructional approaches proposed in contemporary reform proposals. In a three-round Delphi study, 11 experts reviewed and internally validated an ID model that met the set requirements. The research question for this study was: What are the characteristics of an ID model that supports teachers in continually expanding their repertoire of instructional strategies and how can such a model be internally validated?

Chapter Three

This chapter describes a study that was focused on teachers' intentions to change. Existing approaches to PD mostly lack attention to teachers' willingness to change and are predominantly aimed at the development of knowledge and skills or at creating a positive learning environment (Ball & Forzani, 2009; Borko et al., 2010). In the current study, so-called 'motivating-for-educational-change' interviews (MECI) were performed, after which we studied the development of biology teachers' intentions to change towards the context-based reform proposal. The MECI technique was based on both the modular and the success-oriented approach (see section 1.3.3). The research question for this study was: What are the developments in the strength and specificity of biology teachers' intentions to implement a context-based educational reform after performing a 'motivating-for-educational-change interview' (MECI), and what are the underlying mechanisms?

Chapter Four

In the study described in the fourth chapter, a PD program for biology teachers was designed and performed. This PD program was based on three design principles: (1) allow teachers to build upon earlier successful experiences (success-oriented approach); (2) allow teachers to attain the goals of the reform proposal by recombining and adjusting their existing lesson segments (modular approach); (3) support teachers

from a distance and according to their individual needs. The study was focused on the development of teachers' (n=8) classroom practices and also explored the strength of their intentions for each step in their development during the PD program. The research question was: How do the strength of teachers' intentions and their teaching repertoire develop in the course of a professional development program focusing on practicality in designing and implementing context-based education?

Chapter Five

This chapter describes a PD program in which biology teachers (n=5) collected and used students' data to make changes to their instructional practices. By measuring data on learning outcomes and regulation of learning processes, the teachers were able to monitor the specific effects of their instructional approaches. Next, the teachers used the success-oriented approach while interpreting and using these data to make changes to their instructional practices. During this process, we supported the teachers using three practical frames (Klein, Moon, & Hofman, 2006), all of which were based on the modular approach: (1) every lesson consists of a series of lesson segments, (2) every lesson segment can be regulated by either the teacher, the student, or shared and (3) different types of contexts can have different functions. In this study, we examined to what extent and in what ways teachers used these practical frames, and we also explored how students' data influenced the teachers' development in terms of classroom practices. The research question for this study was: How do practical frames contribute to teachers' interpretation and productive use of students' data on learning outcomes and regulation of learning processes in the setting of a PD program, and what are the influences of using such students´ data on teachers´ professional development?

These four studies together were used to answer the following overarching research question of this research project:
How can the context-based approach to biology education be made practical for teachers?
In Chapters 3 and 4, we explicitly focused on the strength of teachers' intentions to make changes in line with the reform. In Chapter 3, we studied the strength and

specificity of teachers' intentions prior to any attempt at change. In chapter 4, we studied the strength of teachers' intentions during a PD program in which each teacher designed four lessons. In Chapters 4 and 5, we studied the specific developments in teachers' instructional approaches that resulted from using the modular and the success-oriented approach.